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ABSTRACT

To evaluate the effects of selected treatment and classification factors on the preparation of high school students for initial entry into agricultural occupations other than farming, and to compare the effectiveness of structuring agricultural subject matter based on the principles approach with the traditional approach, 24 Nebraska schools were randomly selected for this pilot study. For Phase I, the four treatment groups of related instruction, directed work experience, a combination of related instruction and direct work experience, and a control group were evaluated in a three-way analysis of covariance design. No statistical differences in the various treatment combinations were found although students with no exposure to related instruction scored higher on the work-opinion inventory. Phase II of the study evaluated the principles approach in teaching agricultural subject matter based on a standardized agricultural achievement test. It was found that the achievement of subjects taught by the principles approach was equal to or significantly greater than the control group. A major problem in Phase I was lack of an adequate dependent variable measurement, and in Phase II it was difficult to get teachers to completely adopt the new method of instruction. Appended are the instruments used in the study, the agricultural principles taught, and a course of study for off-farm agricultural occupations. (DM)

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James T. Horner
Roland L. Peterson
Leo M. Harvill

University of Nebraska
Lincoln, Nebraska

June, 1969

U.S. DEPARTMENT OF
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SUMMARY

The central problem of this study was to evaluate the effects of selected treatment and classification factors on the preparation of high school students for initial entry into agricultural occupations other than farming. A secondary phase of the study was to compare the effectiveness of structuring agricultural subject matter based on the "principles" approach with the traditional approach.

Twenty-four randomly selected Nebraska schools, excluding the metropolitan high schools of Lincoln and Omaha comprised the sample for this pilot study. Students enrolled in grades 10-12 constituted the subjects studied. Sixteen of the twenty-four schools offered vocational agriculture courses prior to this study. The remaining eight schools initiated a program of vocational agriculture instruction when the study began.

For Phase I the twenty-four schools in the pilot study were randomly arranged into four treatment groups, namely, related instruction, directed work experience, a combination group of related instruction and directed work experience, and a control group. A 2 x 2 x 3 analysis of covariance with repeated measures on the third factor was the experimental design utilized. One factor was that of presence or absence of related instruction. The second factor was labeled directed work experience; and the third factor was the year of the project.

Phase I of this investigation involved an analysis of selected instructional procedures for initial entry into Off-Farm Agricultural Occupations. The three test instruments which were used to determine the most effective treatment in educating high school students were the "Test on General Information for Prospective Workers," the "Work Opinion Inventory," and the "Off-Farm Agriculture Occupations Opinion Inventory."

An analysis of these three measures revealed no statistical differences among the various treatment combinations in regard to the most effective way of educating high school students for off-farm agricultural occupations. The only significant F value revealed that subjects with no exposure to the related instruction factor scored higher on the "Work Opinion Inventory" than did those with related instruction. On all three measures, the combination group with work experience and related instruction was the lowest of the four groups; however, the differences were not significant. It should be noted that a number of teachers in the study felt that the combination treatment group of related instruction and work experience provided students with the most

meaningful learning experiences. A majority of the teachers said they would implement the combination of work experience and related instruction at the close of the study.

A follow-up study was also conducted on the subjects in the four treatment groups. An overall observation of the returned questionnaires revealed that after receiving instruction in any one of the four treatment groups, subjects were most frequently employed in a non off-farm agricultural occupation. Some caution is suggested concerning the follow-up data due to the fact that considerable variation existed in the number of students in each treatment group. Consequently differences may have been due to the number of subjects in each treatment group. However, the following observations were considered meaningful in an examination of the data. The follow-up study revealed that subjects in the combination (work experience and related instruction) group were initially employed in off-farm agricultural occupations at a higher percentage than any other treatment group. A comparison of the number of subjects going to college showed that the control group had the highest percentage. The highest percentage of subjects entering the military service was found in the control group. The number of students listed as being unemployed or unknown was extremely small.

Phase II of this study was the curriculum phase. For this aspect the twenty-four schools were divided into three equal groups: new schools with principles curriculum, old schools with principles curriculum, and old schools with traditional curriculum. The new schools group consisted of eight public high schools which had not previously offered courses in vocational agriculture; however, they initiated these courses at the beginning of the present study. The old schools with principles consisted of eight schools which had previously offered vocational agriculture; however, they changed the orientation of their courses from being problem-centered to being principle-centered. The old schools with a traditional curriculum served as the control group and the curriculum remained problem-oriented for the duration of the study. This phase was concerned with comparing two methods of organizing and teaching agricultural subject matter. An experimental principles approach was compared with a traditional enterprise problem-solving approach. The following three agricultural achievement tests were developed to compare the effectiveness of each approach; namely, "Test on the Principles of Plant and Animal Science," "Test on Mechanics," and "Test on Agricultural Management and Marketing Principles." The analysis indicated that the achievement of subjects in the principles approach was significantly greater than the achievement of subjects taught agricultural subject matter in a traditional manner for the 1965-66 school year and the 1966-67 school year. In the 1967-68 school year, there was no significant difference in the achievement of subjects taught agricultural subject matter based on principles and those taught in a traditional manner.

To assess the overall effectiveness of the curriculum phase of the study, a standardized agricultural achievement test was administered to the subjects who had been in one of the three treatment groups for all three years of the study. The overall analysis served to further reinforce the above findings. The findings revealed that the subjects taught agricultural subject matter based on the principles approach achieved equal to or significantly greater than students taught in a traditional manner.

AN EXPERIMENTAL EVALUATION OF APPROACHES TO PREPARING HIGH SCHOOL STUDENTS FOR AGRICULTURAL OCCUPATIONS OTHER THAN FARMING
and
(PRINCIPLES VERSUS TRADITIONAL APPROACH TO TEACHING VOCATIONAL AGRICULTURE)

CHAPTER I

INTRODUCTION

Purpose of the Study

The purpose of this study was to evaluate the effectiveness of selected treatment and classification factors on the preparation of high school students for initial entry into agricultural occupations other than farming, as measured by dependent variables described in a subsequent section of this investigation. The central problem has two components:

1. A comparison of three programs for preparing high school students for initial entry into agricultural occupations other than farming with a control group. These four treatment groups were incorporated into 2 x 2 x 3 analysis of covariance experimental design with repeated measures across the third factor.

2. The relative effectiveness of two patterns of curriculum organization in vocational agriculture courses of study.

Definition of Terms

For purposes of clarification for this study, the following terms have been defined as follows:

1. Treatment factor. A treatment factor is a condition of the experiment controlled by the investigator. The "pilot" programs and the curriculum organization, therefore, were treatment factors.

2. Classification factor. A classification factor is a natural stratification or dichotomization of schools or pupils on a variable of interest, which is not subject to control by the investigators except that the levels of ranked quantitative factors may be determined by the investigators.

3. Experimental unit. The treatment combinations were applied to individual students. However, the design of the experiment required that the data be grouped by class or school. Thus, the classes or schools served as intact experimental units.

4. Schools. Schools referred to the high school attendance unit, grades 10, 11, and 12 specifically, to the department of vocational agriculture within the school, and/or school community.

5. Agricultural occupations other than farming. Agricultural occupations other than farming are occupations in which competencies in one or more of the areas of plant science, animal science, soil science, agricultural business management and marketing, and agricultural mechanics are needed for employment. These occupations have also been referred to as off-farm agricultural occupations.

6. Instruction in vocational agriculture. Instruction in vocational agriculture refers to the instruction in the five areas of plant science, animal science, soil science, agricultural business management and marketing, and agricultural mechanics.

7. Pilot Programs. A pilot program refers to a planned activity for testing a new idea in a realistic field situation.

8. Diversified Occupations. A cooperative occupational education program in vocational education which is designed to provide occupational experiences (in class and/or on the job) for a wide variety of occupations. These occupations could be related to agricultural education, distributive education, business and office education, health education, home economics education, or trade and industrial education.

Importance of the Problem

The Vocational Education Act of 1963 amended the previous Vocational Education Acts of 1917 and 1946. This legislation along with research in this area provided the basis for program expansion in vocational education in agriculture.

During the past decade, agricultural educators, in increasing numbers--e.g., Hopkins (1956), Juergenson (1953), Nichols (1956), and Sutherland (1956)--have advocated program expansion in vocational education in agriculture, both in terms of the clientele to be accommodated and of the objectives set forth for the program. Chase (1954) reported that teacher educators in agricultural education favored a "modernization" of the program, and Nylund (1956) reported similarly, regarding opinions of teachers of vocational agriculture. Bender (1961) and Ekstrom (1957) indicated that approximately 10 percent of the former students enrolled in vocational agriculture are engaged in agricultural occupations other than farming, and Bishop and Tolley (1963) supplied data to the Panel of Consultants on Vocational Education to denote that 100,000 new positions in agricultural occupations other than farming may be expected by 1970. The importance of knowledge and skills in agriculture in agricultural occupations other than farming has been demonstrated in a number of studies, such as the ones reported by Courtney (1962) and Kennedy (1959). Sutherland and Thompson (1957) found that approximately 20 per cent of the workers in 327 California agricultural businesses held positions for which some measure of agricultural training was considered desirable.

Section 4 (a) (1) of the Vocational Education Act of 1963 provides that States may use a portion of their allotment under this Act to provide vocational education for persons who are attending high school, and Section 10 (b) of the same Act amends the Vocational Education Acts of 1917 and 1946 to provide that "any amounts allotted or apportioned under such titles, Act, or Acts for agriculture may be used for vocational education in any occupation involving knowledge and skills in agricultural subjects, whether or not such occupation involves work of the farm or of the farm home, and such education may be provided without directed or supervised experience on a farm."

The immediate impact of this Act was to expand the clientele to be served by programs of vocational agriculture. If programs of vocational agriculture are to meet the broadened responsibility thrust upon them by this amendment, then it is imperative that attention be given to determining the extent to which agricultural knowledge and skills are needed by workers in the labor force, and how best to provide them.

Review of Literature

Off-Farm Agricultural Occupations Phase

Analytical studies have been found in the literature which compare graduates of vocational agriculture programs employed in agricultural occupations other than farming with individuals who have not had such educational preparation. Sutherland and Thompson (1957) found that training in vocational agriculture is desirable for people who are in occupations related to distributing, processing, and other related services for agriculture. In a later study, Royster (1960) reported the same findings. According to Hoover (1957) workers who are in off-farm agricultural jobs but had vocational agriculture school programs are presently being paid higher wages, are more satisfied with their jobs and wages (according to a job satisfaction scale), and had higher positions than did employees with no such training in their high school years. Clark (1959) used farm business managers as his subjects in his investigation and found that more than two-thirds of them felt that training in farm skills was indispensible for initial employment in the businesses they operated.

Research in program development in vocational education in agriculture for high school pupils during the first half of the current decade has centered upon the development of experimental, pilot, and demonstration programs. Innovations in programs of vocational education in agriculture resulting from the broadened purposes of agricultural education incorporated into the Vocational Education Act of 1963 have been concerned chiefly with programs designed to prepare for employment and advancement in the nonfarm occupations involving knowledge and skill in agricultural subjects. Clary (1964) and Phipps (1965) have indicated guides for establishing pilot programs in agricultural education.

Clark's (1963) study of a pilot program in Michigan was one of the first efforts to develop and evaluate a program designed specifically for high school pupils interested in the nonfarm businesses and industries. A pilot program in agricultural distribution conducted in Virginia was described by Wilson and Witten (1965). Hoover and Weyant (1965) described a pilot study involving 25 Pennsylvania high schools. Hemp, Phipps, Warmbrod, Ehresman, and McMillion (1966) evaluated pilot programs in Illinois which had as their main focus innovations in educational programs for high school pupils who were preparing for gainful employment in both farm and non farm occupations. The report of this two-year study (Hemp et. al., 1966) included a comprehensive list of guidelines and suggestions for planning and conducting programs in agricultural occupations for high school pupils. Binkley (1965), drawing upon the results of pilot programs in Kentucky, developed an excellent guide for use in planning, conducting, and evaluating programs in nonfarm agricultural occupations. In this program, vocational agriculture students have been given instruction in related information and have engaged in practical work experience programs under the direction of the school to prepare for agricultural occupations other than farming. The pilot program was completed on June 30, 1965, after 18 successful months of operation. It proved effective in preparing students for "job entry" in agricultural-supply businesses. In teaching the class, demonstrations, resource people, role playing, and modified problem-solving procedures were used. The problems were concerned with practical and realistic situations in which the local owners and managers of the stores encountered in their daily work activities. The daily instruction was kept flexible to allow for seasonal and employer-employee problems to be dealt on a timely basis. These students were placed in agricultural-supply businesses for training after a few weeks of class instruction.

The use of pilot, experimental, and demonstration programs as a means of developing, evaluating, and implementing educational programs is a new dimension in agricultural education. Researchers should continue to use and refine this technique of program innovation and evaluation.

Principles Phase

In regard to the curriculum phase of the study, a review of the literature revealed relatively few reports of research in structuring agricultural subject matter existed. Considerable emphasis is being placed upon the educational and occupational needs of workers in which agricultural knowledge is needed. However, few studies have focused on organizing or structuring subject matter for the purpose of exploring other approaches for presenting agricultural subject matter to students.

A study by Sutherland and Sams (1963) focused on structuring agricultural subject matter around basic underlying biological principles. In their pioneering study, they found that it was feasible and practical to teach biological principles in agriculture in the secondary school. They also found that principles can be integrated into the agricultural course without eliminating important areas of agricultural content and the average vocational agriculture student can master and understand the material. They suggested that it has long been accepted that principles should be taught with application and teaching is more effective when the principle and its application are presented in close association.

Two pioneering field studies conducted by Elkins and Johnson (1960) and Seargeant (1963) provided a list of mechanical principles with agricultural applications.

As a result of the study by Sutherland and Sams (1963), Starling (1965) studied the feasibility of integrating the biological principles with vocational agriculture instruction in Ohio. He found at the .01 and the .05 levels, greater differences between pre-test and post-test levels in agricultural achievement, biology achievement, and interest for students in the pilot or experimental schools. He further indicated that the biological principles approach appeared to make vocational agriculture more challenging to students by placing more emphasis on "why" rather than "how."

In a companion study to the present investigation conducted by Peterson (1969) at the University of Nebraska, the achievement of students taught agricultural subject matter based on principles was compared with those taught agricultural subject matter based on enterprise problems in four subject matter areas. Animal science was taught at the ninth grade level; animal, plant and soil science at the tenth grade level; agricultural mechanics at the eleventh grade level; and agricultural marketing and management at the twelfth grade level. He found that for the ninth grade animal science and eleventh grade agricultural mechanics courses, students attained significantly greater achievement ($p < .05$) when taught agricultural subject matter based on principles. He also found that for the tenth grade plant science and twelfth grade agricultural management courses, no significant differences ($p > .05$) existed in the achievement of students in the two treatment groups. An overall analysis of all four grades resulted in significantly greater ($p < .05$) achievement for students taught agriculture based on the principles approach. He concluded that the achievement of students taught agriculture subject matter resulted in significantly greater ($p < .05$) achievement for students taught agriculture based on the principles approach.

In a study to measure the understanding of basic profit maximizing principles essential for efficient operation and management of a farm business by adult farmers in Ohio, McCormick (1964) found a direct correlation between the understanding of principles and the number of years of schooling completed. He found that older farmers had less understanding of basic principles than younger farmers. He also indicated there was no significant relationship between the relative level of understanding of basic principles and the application of these principles to the farm.

Studies conducted by Steffy (1965) and Layman (1965) revealed that principle directed teaching yielded significantly greater achievement in teaching farming program record keeping. These studies also indicated that mere memorization of facts and skill development could no longer provide the agriculturalist with the understandings needed for competent participation in the technical aspects of agriculture.

A series of studies conducted by Krueger (1965), Dunham (1963), Shirley (1963), and Way (1967) revealed that the principles approach was conducive to teaching concepts, consolidating fragmented subject matter, conserving time, and providing a more meaningful instructional program. They also stated that teachers were expressing considerable interest in the new approach.

During the past decade, educators have expressed a great deal of interest in the principles approach in a number of articles in the periodical literature of agricultural education. Articles by Hammonds (1964), Cushman (1968), Richard (1964), Nielson (1967), and Steele (1962) urged agricultural educators for a more structured course of study. They suggested that the farmer or agricultural student who understands both how and why a certain procedure is followed will possess the ability to think through the problems of production and distribution of agricultural products. They also indicated that teachers of agriculture have done a better job of teaching how than of teaching why with little doubt that their teaching has been limited to practices which change very rapidly, whereas basic principles become the essential foundations of education in agriculture.

Dale (1968) suggested that a major waste in education is the failure to learn depth. He stated that this occurs when students become fact-oriented rather than principle-oriented and application-oriented. Michelson (1965) revealed that what to teach and how to teach it is the central theme facing curriculum workers in all areas of education today. He stated that a blending of what, why, and how is necessary today due to the high degree of specialization. He further indicated that academic education too often places emphasis on facts and principles and is never transferred to a useful state, whereas in the vocational approach the principles are rarely, if at all, arrived at.

Gagne and Fleishman (1959) suggested that the use of principles or concepts is one of the most important aspects of human behavior because it allows the individual to generalize previous experiences to a great variety of new situations. Bruner (1961) supported the discovery process of learning, which was used in the principles approach, by indicating that a number of studies have shown that any organization of information which reduces the complexity of material tends to make it more accessible for retrieval. He further suggested that attitudes and activities which characterize figuring out or discovering things seem to have the effect of making material more readily accessible in memory.

In the principles approach, discovery learning is an important characteristic; however, the problem-solving or learning-by-doing activities so prominent in vocational education are also a key aspect. Rich (1962) indicated that learning by doing has almost become an accepted article of faith by educators. He suggested that learning was an active rather than a passive affair for the learner and the role of the school is to so structure the doing that purposeful behavior results from the learning activities.

Theoretical Constructs of the Study

A summary of the literature led to the formulation of theoretical constructs for the study, and the theoretical constructs, in turn, are redefined as hypotheses to be tested in a statistically designed experiment. The summary is as follows:

1. A relatively large portion of federal Vocational Education monies has been expended for vocational education in agriculture at the high school level to prepare high school students for farming.
2. Studies of graduates disclose that a relatively large proportion of the students who were enrolled in vocational agriculture classes in high school have entered agricultural occupations other than farming. Students who have had training in vocational agriculture have excelled persons who did not have vocational agriculture on a number of dependent variables of interest.
3. Opinions of employers indicate that vocational agriculture training has been valuable preparation for entry into agricultural occupations other than farming.
4. An amendment incorporated in the Vocational Education Act of 1963 authorizes federal Vocational Education monies to be used to prepare high school students for any occupation which requires knowledge and skills in agricultural subjects.

From this summary, and from discussions of the problem of preparing high school students for entry into agricultural occupations other than farming at the Central Region Research Conference at Columbia, Missouri, August 4-7, 1964, the following theoretical constructs were elaborated:

1. Instruction in vocational agriculture is essential for entry into agricultural occupations other than farming.
2. For high school students who plan to enter agricultural occupations other than farming, practical, on-the-job, work experience programs under the dir-

ection of the school, at such sites as farm implement dealers, feed stores, or agricultural service agencies, are essential to the preparation of high school students for initial entry into agricultural occupations other than farming.

3. Enrollment and participation in work experience programs should be accompanied by a course in Related Instruction, designed to cover such topics and problems as labor laws, labor relations, employer-employee relations, and work habits and attitudes, and, also, to provide opportunity for directed and supervised study in the specific occupational area of interest to the individual students.

4. Agricultural subjects should be structured around basic underlying principles. The basic subject matter areas of animal, plant and soil science should be developed around the underlying biological science principles; the agricultural mechanics subject matter should be developed around physical science principles; and the farm management and marketing subject matter should be developed around underlying economic principles.

Objectives of the Study

As a result of evidence from the literature concerning a lack of comprehensive research in the field of agricultural education regarding the effectiveness of approaches to preparing high school students for entry into agricultural occupations other than farming and the need for a structuring of agricultural subject matter around basic principles, the following objectives were formulated to guide the present study:

1. To determine if a practical on-the-job institution directed work experience program is essential for initial entry into agricultural occupations other than farming.

2. To determine if a course in related instruction is essential for initial entry into agricultural occupations other than farming.

3. To determine if a difference exists in the achievement of students taught agricultural subject matter based on principles and those taught agricultural subject matter based on enterprise problems in the

following three subject matter areas:

a. Animal, plant and soil science principles taught at the tenth grade level.

b. Agricultural mechanics principles taught at the eleventh grade level.

c. Agricultural marketing and management principles taught at the twelfth grade level.

In the initial planning of the project, it was intended that consideration be given to the impact of varying numbers of years of instruction in vocational agriculture (i.e., 0, 1, 2, and 3). This made it necessary to have a group of schools in which no vocational agriculture had been previously offered. However, due to the fact that the three principles based courses were different, resulting in the measures rather than three replications, and due to the resultant small cell sizes it became unrealistic to attempt so refined an analysis.

CHAPTER II

METHODS OF RESEARCH

This section of the report provides information regarding the selection of the sample, the design of the study, the selection of evaluation instruments and the general procedures followed in completing the study.

Selection of the Sample

A sample of 24 Nebraska high schools was drawn which included eight schools that had not offered vocational agriculture prior to the beginning of the present study and 16 schools which had previously offered a vocational agriculture program. The 16 schools were selected in the following manner:

1. The schools were numbered in the order in which the letter of intent was received prior to the cut-off date. A total of 59 schools expressed interest in the study.
2. A table of random numbers was used to select the schools. The table was entered in a random fashion and the first 16 numbers selected represented the schools that were included in the study. The 17th number was designated as the first alternate, the 18th number drawn was designated as the second alternate, and alternates were selected until a total of 20 alternates had been randomly chosen from the list.

This selection procedure allowed the investigator to generalize to all schools offering vocational agriculture with 100 or more students enrolled in grades nine through twelve in their high schools, excluding high schools in the larger metropolitan areas of Omaha and Lincoln, Nebraska.

The procedure followed in selecting the eight schools which had not previously offered vocational education courses in agriculture was conducted in the following manner.

1. A list of 30 high schools in Nebraska (with student enrollment of 100 or more) interested in establishing or re-establishing programs of vocational education agriculture was developed by consultants in agricultural education in the State Department of Education, Division of Vocational Education. These schools were personally contacted

by Dr. John K. Coster, a principal investigator, and the agriculture consultants in the State Department of Education.

2. The first eight schools agreeing to participate in the study were selected.

Design of the Study

Off-Farm Agricultural Occupations Phase

The 24 schools were assigned randomly to one of the four treatment combinations. Six schools provided related instruction only, another group of six schools provided directed work experience only, a third group of six schools provided both related instruction and directed work experience and the remaining group of six schools provided no related instruction or directed work experience, hence, this group served as a control group for the off-farm agricultural occupations phase of the study.

Related instruction refers to a one-year course of study (180 hours) of related instruction, similar to that offered in programs of Distributive Education. Approximately 90 hours of instruction covered problems of general occupational and employer-employee interest and the remaining 90 hours of instruction covered problems related to the specific agricultural occupation of interest to the student. The related instruction factor had two levels: these were the presence or absence of related instruction.

Directed work experience refers to directed on-the-job experience in an agricultural agency, business, or establishment in the community of not less than 360 hours per year. This factor also had two levels; these were the presence or absence of work experience on-the-job.

The third factor involved in this phase of the study was the years factor. The years of instruction involved the classes of 1966,1967, and 1968. This factor was included to check for continuity throughout the entire project. This factor was considered as a repeated measures factor since the classes, and not individual students, were the actual **experimental units**.

As a result of the three treatment factors, a randomized 2 x 2 x 3 design with repeated measures on the third factor formed the basis for the primary data analysis. With this design, analysis of covariance was used to test the null hypothesis that there was no significant difference in the achievement of students in schools which provided related instruction and/or directed work experience and those schools which provided no related instruction and/or directed work experience.

The following supplementary objectives were also of interest in the off-farm agricultural occupations phase of the study:

1. To determine the number of students who entered off-farm agricultural occupations upon completion of a course which provided:
    a. Related agricultural occupational instruction only.
    b. Directed agricultural occupational work experience only.
    c. Both related occupational instruction and directed work experience.
    d. No related instruction or work experience.

2. To determine the amount of salary per week, the relative degree of job satisfaction, the stability of employment and the tendency to enter other types of work for students receiving instruction in a course which provided:
    a. Related agricultural occupational information only.
    b. Directed agricultural occupational work experience only.
    c. Both related instruction and directed work experience in agricultural occupations other than farming.
    d. No related instruction or directed work experience in agricultural occupations other than farming.

Principles Phase

In recent years, specialists in educational research have expressed a concern regarding the effects of the experimental environment on dependent variables which may influence the results of the experiment. This effect is commonly referred to as the "Hawthorne Effect." The introduction of this aspect of the study placed nearly all the schools in an experimental environment, thus providing a constant effect for all treatment combinations. Secondly, curriculum writers in secondary education and agricultural education have been concerned about the relative merits of patterns of curriculum organization. Studies reported in the review of literature indicated that curriculum workers are extremely interested in organizing agricultural subject matter for effective presentation to students.

Thus, the addition of this phase provides an economical means for studying the influence of a new pattern of subject matter organization.

One half of the sixteen experimental schools which offered vocational agriculture prior to the inception of this study were randomly assigned to teach agricultural subject matter based on underlying animal, plant, and soil science principles for tenth grade students during the 1965-66 school year, mechanical principles to the eleventh grade students during the 1966-67 school year, and agricultural marketing and management principles to the twelfth grade students during the 1967-68 school year. The remaining eight schools which offered vocational agriculture prior to the inception of this study taught agricultural subject matter in a traditional manner based on enterprise problem-solving procedures. The eight new schools were assigned to teach agricultural subject matter based on the principles approach. Thus, the combinations of eight new and eight existing schools taught agricultural subject matter based on principles, whereas, eight of the schools where courses in vocational agriculture existed prior to the present study taught agricultural subject matter based on a traditional enterprise problem-solving approach. The implementation of this phase of the study resulted in the formation of three groups of eight schools each.

One-way univariate and multivariate analyses of covariance were used to test the null hypothesis that there was no significant difference in the achievement of students in schools which taught agricultural subject matter based on principles and those schools which taught agricultural subject matter based on enterprise problems. The univariate analyses involved the analysis of an achievement test each year for the 1965-66, 1966-67, and 1967-68 schools years. The multivariate analysis involved a comparison of achievement based on a standardized four-part agricultural achievement test.

In summary, Table I reveals the overall design of the present study.

TABLE I

NUMBER OF SCHOOLS IN EACH TREATMENT GROUP
FOR THE TWO PHASES OF THE STUDY

	Treatment 1 New Schools, Principles	Treatment 2 Old Schools, Principles	Treatment 3 Old Schools, Traditional	Total
Related Instruction	2	2	2	6
Work Experience	2	2	2	6
Combination*	2	2	2	6
Control**	2	2	2	6
Total	8	8	8	24

*Related Instruction and Work Experience
**No Related Instruction or Work Experience

Hypotheses

Off-Farm Agricultural Occupations Phase

The following hypotheses were developed to guide the researchers in the analysis and interpretation of the data for the off-farm agricultural occupations phase of the study:

1. There is no significant difference on the Test of General Information for Prospective Workers between respondents receiving related instruction and students not receiving related instruction.

2. There is no significant difference on the Off-Farm Agricultural Occupations Opinion Inventory between respondents receiving related instruction and respondents not receiving related instruction.

3. There is no significant difference on the Work Opinion Inventory between respondents receiving related instruction and students not receiving related instruction.

4. There is no significant difference on the Test of General Information for Prospective Workers between respondents receiving work experience and students not receiving work experience.

5. There is no significant difference on the Off-Farm Agricultural Occupations Opinion Inventory

between respondents receiving work experience and respondents not receiving work experience.

6. There is no significant difference on the Work Opinion Inventory between respondents receiving work experience and students not receiving work experience.

7. There is no significant difference on the Test of General Information for Prospective Workers between respondents receiving both related instruction and work experience as opposed to none.

8. There is no significant difference on the Off-Farm Agricultural Occupations Opinion Inventory between respondents receiving both related instruction and work experience as opposed to none.

9. There is no significant difference on the Work Opinion Inventory between respondents receiving both related instruction and work experience and respondents not receiving both related instruction and work experience as opposed to none.

Follow-Up Phase:

It was felt by the investigator that a follow-up study of students would yield valuable data. However, due to the subjective nature of the data, some caution must be exercised in comparing and drawing implications from the follow-up information. The following hypotheses were developed to guide in a summary of the follow-up data:

1. There is no observable difference on the job satisfaction follow-up, employability, stability of employment, tendency to enter related types of work, salary per week, number of hours worked per week between respondents receiving related instruction and those not receiving related instruction.

2. There is no observable difference on the job satisfaction follow-up employability, stability of employment, tendency to enter related types of work, salary per week, number of hours worked per week between respondents receiving work-experience and students not receiving work experience.

3. There is no observable difference on job satisfaction follow-up, employability, stability of employment, tendency to enter related types of work,

salary per week, number of hours worked per week between students which received both related instruction and work experience and respondents not receiving both related instruction and work experience.

Principles Phase:

The following hypotheses were designed to aid the researchers in the analysis and interpretation of the data acquired on the curriculum factor of this study:

1. There is no significant difference on the Test of Principles of Plant and Animal Science between respondents having the Principles approach and those not having the Principles approach.

2. There is no significant difference on the Test on Principles of Mechanics between respondents having the Principles approach and those not having the Principles approach.

3. There is no significant difference on the Test on Agricultural Management and Marketing Principles between respondents having the Principles approach and those not having the Principles approach.

4. There is no significant difference on the Agricultural Achievement Test between subjects having the Principles approach and those not having the Principles approach.

Collection of the Data

The following procedures were used to gather the data for the present study:

1. The initial step was to select personnel as research associates. This step was initiated during the spring of 1965. Research associates were employed for preparing instruments, administering tests, collecting data, preparing curriculum materials for the curriculum phase, preparing materials for the off-farm agricultural occupations phase, provide in-service education for the teachers and assist in the field direction of the project. During the spring of 1965, 16 schools offering vocational agriculture were randomly selected from a list of Nebraska secondary schools that expressed an interest in the project. The research associates prepared test instruments (See Appendix A) and curriculum materials concerning

animal, plant and soil science principles during this period. (See Appendix B)

2. During the summer of 1965 the 24 Nebraska teachers selected were trained by the principal investigators and the research associates.

3. In September of 1965, the project began by administering the experimental pre-tests to the students in the study.

4. During the 1965-66 school year, the research associates made two supervisory visits to the teachers, collected community data, prepared curriculum materials in regard to agricultural mechanics principles, (See Appendix B) the off-farm agricultural education materials were developed, (See Appendix C) and test instruments for measuring agricultural achievement were also developed.

5. At the close of the 1965-1966 experimental post-tests were administered and initial follow-up data were collected. (See Appendix A).

6. The months of June, July, and August of 1966 were devoted to in-service education for new teachers due to turnover in the project schools. The research associates also continued the development of curriculum materials in agricultural mechanics principles and revised the animal, plant and soil science principles, as well as the off-farm agricultural occupations materials.

7. During September of 1966 the experimental pre-tests were administered for the curriculum and off-farm agricultural occupations phases of the study.

8. During the fall of 1966 follow-up data were collected on the May 1966 graduates. The research associates continued to make supervisory visits to the project schools as well as the revision of animal, plant, and soil science principles and the off-farm agricultural occupations materials.

9. A preliminary analysis of the first year data was also completed during the 1966-1967 school year.

10. In May of the 1966-1967 school year experimental post-tests were administered to the students involved in the study.

11. During the months of June, July and August, 1967, the agricultural marketing and management principles, (See Appendix B) were developed along with a test instrument to evaluate the principles in the curriculum phase of the study. In-service educational programs were provided for the new teachers who were employed in the project schools as a result of turnover.

12. In September of 1967 the experimental pre-tests were administered and follow-up data for the May 1967 graduates were collected.

13. During the 1967-1968 school year, supervisory visits to the project schools were conducted by the research associates. Preliminary data analysis was conducted along with an evaluation of the research project by Dr. John K. Coster of North Carolina State University, Dr. Douglas Sjogren of Colorado State University, Dr. Emil Heermann of the University of Nebraska, Dr. James McComas of Kansas State University, and Mr. Glen Strain of the Nebraska State Department of Education.

14. In May of 1968 the experimental post-tests were administered along with the collection of follow-up data for students in the 1966, 1967 and 1968 graduating classes.

15. The analysis of data was conducted by the research associates during the months of June, July and August of 1968.

16. In June of 1969 follow-up data were collected for all students.

17. The final report was prepared in the summer of 1969.

Instruments Used in the Study

The present study was designed to compare the relationship between the dependent variables (change in achievement and attitude) and a number of independent variables. The dependent variables were selected or prepared to obtain information regarding the entry of students into agricultural occupations other than farming for the OFAO phase and to assess the agricultural achievement of students in the curriculum phase of the study. The dependent variable of primary concern in the off-farm agricultural occupations phase of the project was obtained from scores on a test of related information, pertaining to the general occupational related information. The other dependent variables were obtained from the following sources:

1. Scores on a scale designed to measure attitude toward work.

2. Scores on a scale designed to measure attitude toward agricultural occupations.

The scores obtained on the above listed dependent variables were assumed to be measured on an integral scale. The scores were assumed normal and independently distributed in the population about a true population mean with the unit standard deviation. Pre-test and post-test experiment scores were obtained on the dependent variables.

The test instruments used to gather the data were constructed as a part of the study. The instruments were subjected to an item analysis and a test of reliability. The Flanagan and the Kuder-Richardson formulas were used to measure the reliability of the test instruments developed by researchers for the present study. The validity of each instrument was maintained by having a subject matter specialist prepare the items and a review of each instrument was conducted by a university professor in each subject matter field. A team of specialists in educational and psychological measurements were responsible for constructing and administering the measurement instruments.

The following instruments were developed and used for the Off-Farm Agricultural Occupations phase of the study:

1. "Test of General Information for Prospective Workers." (See Appendix A). This tool was developed by an educational psychologist and a specialist in the area of cooperative occupational education. After an item analysis, the final form consisted of 60 four-choice questions. The Flanagan procedure reported a reliability of .570. The Kuder-Richardson 21 method indicated a reliability of .488. These reliability coefficients were obtained from the pre-test scores of the seniors in the 1966 class involved in the present study. This tool was used as both a pre-test and a post-test for the seniors in 1966, 1967, and 1968 classes.

2. "Work Opinion Inventory." (See Appendix A). This inventory was constructed by an educational psychologist. It contains 25 five-choice response type items organized in a Likert-type scale. The response continuum ranges from strongly agrees to

strongly disagrees. This tool was utilized to measure one's attitude toward work. Seniors were exposed to this instrument as both a pre-test and post-test. The instrument was used all three years.

3. "Off-Farm Agricultural Occupations Opinion Inventory." (See Appendix A). An educational psychologist constructed this inventory. Off-farm agricultural occupations were defined as occupations in which agricultural knowledge and skills were needed for successful work in the occupation. The knowledge and skill areas included plant science, animal science, social science, agricultural business, management and marketing, and agricultural mechanics. This tool was utilized to measure one's attitude toward off-farm agricultural occupations. The test contained 30 items of a five-choice Likert-type scale. The response continuum ran from strongly agree to strongly disagree. The instrument was used all three years.

4. "Job Questionnaire." (See Appendix A). This tool was adapted from a scale developed by Brafield and Rothe. The 18 items offer a five-choice response range from strongly agree to strongly disagree. The tool was utilized in the follow-up phase of this study to measure one's attitude toward his job.

5. "Job Description." (See Appendix A). This tool was used in the follow-up phase of the project. Students were asked to indicate their employment dates, salary per week, and the number of hours they worked per week. This was administered in four time intervals: two month follow-up, one year follow-up, two year follow-up, and three year follow-up.

The following instruments were developed for evaluating the Curriculum phase of the study:

1. "Test on the Principles of Plant and Animal Science." (See Appendix A). This test was developed by an agricultural educator. After an item analysis, 90 questions with a five-choice response design remained. This test was administered as both a pre-test and post-test to the sophomores in the study. The Flanagan procedure resulted in a reliability of .754; the KR-21 method produced a similar reliability of .795. These coefficients were obtained from the pre-test scores of the subjects in the present investigation.

2. "Test on Principles of Mechanics." (See Appendix A). This test was also developed by agriculture educators who were well acquainted with the curriculum content material. Again, 90 questions with five-choice responses were administered as both a pre-test and post-test to the junior subjects. This test had a reliability of .846 according to the Flanagan procedure and .821 according to the KR-21 test of reliability. These coefficients were obtained from the pre-test scores of the subjects in the present study.

3. "Test on Agricultural Management and Marketing Principles." (See Appendix A). This test, like the above two, was developed by agriculture educators. The 90 item, five-choice multiple response tool was administered both as a pre-test and post-test to the senior subjects in this study. This test had a reliability of .852 using the Flanagan formula and .908 using the KR-21 formula. These coefficients were obtained from the pre-test scores of the subjects in the present study.

4. "Agricultural Achievement Test." (See Appendix A). This test has been standardized. Both state and national norms were developed. Two hundred sixty-seven schools in the nation were sampled, and 68 Nebraska schools were involved. The final national sample consisted of 1200 tenth graders and 1,016 twelfth graders. The state sample involved 51 per cent of all high schools in Nebraska offering vocational agriculture and approximately 25 per cent of all tenth and twelfth grade vocational agriculture students. This test has four subtests: plant and soil science, mechanics, animal science, and management. Each of these subtests consists of 60 questions with five-choice responses. Split-half reliabilities were obtained from a sample of 192 twelfth grade vocational agriculture students with the Flanagan and Kuder-Richardson 21 formulas.

	Flanagan	KR-21
Part I	.88	.89
II	.88	.85
III	.88	.84
IV	.88	.88
Total	.95	.96

The instrument used to obtain intelligence scores for all students was the California Short-Form Test of Mental Maturity, Level V. Although the short form of this test provides less reliable measure than the full test, it was selected for the present study because of its wide acceptance and ease of administration. In addition, the present study did not require a highly precise measure. For a schedule of the approximate dates on which the tests were administered, see Appendix A.

CHAPTER III

FINDINGS AND ANALYSIS

Chapter III presents the analysis of the data that was considered necessary to fulfill the objectives of the study. The data are based on the efforts of 24 randomly selected Nebraska public schools. The 24 schools were randomly assigned to prepare high school students for agricultural occupations other than farming in one of the following four treatment groups during a three-year period:

a. Related occupational instruction only.
b. Directed occupational work experience only.
c. Both related occupational instruction and directed work experience.
d. No related instruction or work experience.

At the same time the 24 schools were also randomly assigned to one of the following three treatment groups to assess the merits of structuring agricultural subject matter around basic biological science, physical science and economic principles:

a. Instruction in agricultural subject matter organized around basic principles in eight schools which did not offer vocational agriculture prior to the initiation of this study.
b. Instruction in agricultural subject matter organized around basic principles, in eight schools which offered vocational agriculture prior to the initiation of the present study.
c. Instruction in agricultural subject matter organized around enterprise problems of the agricultural worker in eight schools which offered vocational agriculture prior to the initiation of the present study.

The first section of Chapter III provides some information about the loss of subjects (schools) from the initial sample and about the final sample size.

The second section is devoted to an analysis of the performance of students in each of the schools in the various treatment groups regarding the off-farm agricultural occupation aspects of the present study. The third section focuses on a follow-up study of employment patterns of students in each of the four treatment groups which were devoted to preparing students for agricultural occupations other than farming. The fourth section presents data concerning the principles phase of the study.

Size of the Treatment Groups

The design of the present study focused on the investigation of a number of treatment factors. In the off-farm agricultural occupations phase of the study, the 24 schools were randomly assigned to four treatment groups. For the principles curriculum phase of the study, the 24 schools were randomly assigned to three other treatment groups. Tables II and III reveal the number of schools involved each year in each phase of the study.

The number of schools in each treatment group for each year was of importance because the school was the experimental unit in this study. The mean of the scores for all students fulfilling the treatment requirements for the school was used as the score of the school for all variables.

TABLE II

NUMBER OF SCHOOLS IN EACH TREATMENT GROUP EACH YEAR IN THE OFF-FARM AGRICULTURAL OCCUPATIONS PHASE OF THE STUDY

Directed Work Experience	Related Instruction					
	Yes			No		
	1966	1967	1968	1966	1967	1968
Yes	6	5	4	6	5	5
No	6	5	4	6	6	6

All 24 schools participated in the study during the 1965-66 school year. At the end of that school term two schools dropped the vocational agriculture program and were thus eliminated from the study. During the 1966-67 school year one of the remaining schools had no students fulfilling the treatment requirements for the off-farm agricultural occupations phase of the study. During the 1967-68 school year the same school, along with two others, had no students fulfilling the treatment requirements for the off-farm agricultural occupations phase of the study. Additional comments will be made regarding this situation in the final chapter. Thus there were a total of 19 schools which completed the off-farm agricultural occupations phase of the study and only the data from these 19 schools were used in the analysis of this phase.

TABLE III

NUMBER OF SCHOOLS IN EACH TREATMENT GROUP
EACH YEAR IN THE PRINCIPLES PHASE OF THE STUDY

Treatment Group	Year 1966	1967	1968
New School, Principles	8	8	8
Old School, Principles	8	7	7
Old School, Traditional	8	7	7
Total	24	22	22

In the principles phase the data from all 24 schools were used in the analysis for the 1965-66 school year. The data from the 22 remaining schools were used for the 1966-67 and 1967-68 school years. For the analysis of the Agricultural Achievement Test, data were taken from those students who had been involved in the study all three years. Only 21 of the 24 schools had students fulfilling this requirement.

Analysis of the Off-Farm Agricultural Occupations Phase

The initial step followed in the analysis of the data for the off-farm agricultural occupations phase of the study was to determine which of the data gathering instruments would provide the most meaningful information when selecting the treatment most effective for educating high school students for off-farm agricultural occupations. The three measures selected for determining the most effective means of educating students for off-farm agricultural occupations were the Test on General Information for Prospective Workers, the Work Opinion Inventory and finally the Off-Farm Agricultural Occupations Opinion Inventory. It was felt by the researchers that these three measures would also compliment the follow-up data in which actual entry into occupations would be observed along with student satisfactions in those occupations.

The Test on General Information for Prospective Workers is an achievement test covering the general material taught in the related instruction classes. The Work Opinion Inventory is a measure of the individual's opinion toward work in general. The Off-Farm Agricultural Occupations Opinion Inventory measures opinion toward off-farm agricultural occupations. Each of these instruments was administered in

September and May to all students involved in the off-farm agricultural occupations phase of the study.

A 2 x 2 x 3 analysis of covariance with repeated measures across the third factor (years) was used for each of the three post-test measures. In order to determine which of the many measures to use as covariates, a step-wise multiple regression was carried out for each of the three measures. A total of 24 variables were chosen as possible covariates by the research staff. These variables were:

1. The pre-test score of the measure involved.
2-5. The pre-and post-test scores of the other two measures mentioned above.
6-10. Agricultural Achievement Test scores, Parts I-IV and Total.
11-13. California Test of Mental Maturity scores, Language, Non-Language, and Total.
14. Bennett Test of Mechanical Comprehension score.
15. Strong Vocational Interest Blank, Farmer score.
16. Number of years of study in vocational agriculture in high school. (See Appendix A)
17. Rank in graduating class. (See Appendix A)
18. Occupational aspirations. (See Appendix A)
19. Occupational plans. (See Appendix A)
20. Attitude scale (attitude toward the teacher and his classroom procedure). (See Appendix A)
21. Rank of the teacher among the teachers involved in the study.
22. Number of years of teaching experience. (See Appendix A)
23. Number of hours of coursework the teacher had beyond the B.S. degree. (See Appendix A)
24. Percentage of students who live on a farm. (See Appendix A)

The step-wise multiple regression on the Test on General Information for Prospective Workers revealed that the best possible covariates would be:

1. Test on General Information for Prospective Workers, Pre-Test score.
2. Number of hours of coursework the teacher had beyond the B.S. degree.
3. Agricultural Achievement Test score - Part IV
4. Number of years of study in vocational agriculture in high school.
5. Occupational plans of the students.

The best possible covariates for the analysis of the scores from the Work Opinion Inventory were:

1. Work Opinion Inventory, Pre-Test score.
2. Strong Vocational Interest Blank, Farmer score.
3. Number of years of study in vocational agriculture in high school.

The step-wise multiple regression indicated that the best possible covariates for the analysis of the scores from the Off-Farm Agricultural Occupations Opinion Inventory were:

1. Off-Farm Agricultural Occupations Opinion Inventory, Pre-Test score.
2. Agricultural Achievement Test score - Part IV.

Thus, the results of the step-wise multiple regression showed that, in each case, one of the best possible concomitant variables was the pre-test score on the measure since it was significant at the .05 level in each case. The pre-test score appeared to be the most logical covariate also.

The pre-test scores from each of the three measures were used as the only covariates. It was determined that only one covariate should be used for each analysis because for each covariate involved in the analysis a degree of freedom was lost. Since the final sample consisted of only 19 subjects (schools), and since it was felt that the pre-test measure was an essential covariate for the analysis, no other concomitant variables were used.

In adjusting for the covariate in each analysis, the assumption was made that the regression coefficient for between-subjects was equivalent to the regression coefficient for within-subjects. Thus, the regression coefficient for within-subjects was used for all adjustments (Winer, 1962). This is a logical assumption if the covariate has not been affected by the treatment.

The results of the analysis of covariance on the post-test scores of the Test on General Information for Prospective Workers are given in Table IV. There were no significant F values at the .10 level of significance. However, the F value for the Work Experience factor showed a trend toward significance ($p. < .25$). This trend indicated that students in schools with no directed work experience scored higher on the test than students in schools with directed work experience. The adjusted means for the two groups were 26.48 and 24.72 respectively. Table V presents the adjusted and unadjusted means for the Test on General Information for Prospective Workers.

TABLE IV

ANALYSIS OF COVARIANCE SUMMARY TABLE FOR THE TEST ON GENERAL INFORMATION FOR PROSPECTIVE WORKERS

Source of Variation	Sum of Squares	DF	Mean Square	F
Between Subjects	225.864	18		
Related Instruction	0.194	1	0.194	0.016
Work Experience	29.062	1	29.062	2.408
RI x WE	15.583	1	15.583	1.291
Error (between)	181.025	15	12.068	
Within Subjects	458.681	37		
Year	29.078	2	14.539	1.088
RI x Year	34.514	2	17.257	1.291
WE x Year	6.859	2	3.430	0.257
RI x WE x Year	0.700	2	0.350	0.026
Error (within)	387.530	29	13.363	
Total	684.545	55		

TABLE V

ADJUSTED AND UNADJUSTED MEANS FOR THE TEST ON GENERAL INFORMATION FOR PROSPECTIVE WORKERS

Adjusted Means

Treatment	Year 1965-66	Year 1966-67	Year 1967-68	Mean
Control	25.17	26.55	26.28	26.00
Work Experience	24.30	25.33	26.46	25.36
Related Instruction	27.92	25.23	27.72	26.96
WE and RI	24.22	21.96	26.08	24.08
Mean	25.40	24.77	26.64	25.60

Unadjusted Means

Treatment	Year 1965-66		Year 1966-67		Year 1967-68	
	Pre	Post	Pre	Post	Pre	Post
Control	21.27	21.72	22.58	24.50	21.87	23.47
Work Experience	22.32	21.96	24.26	25.06	23.44	25.32
Related Instruction	24.32	27.72	24.97	25.72	23.97	27.15
WE and RI	30.17	30.25	29.92	27.72	25.02	26.62

The results of the analysis of covariance on the post-test scores of the Work Opinion Inventory are given in Table VI. The F value for the related instruction factor was significant at the .05 level. However, the groups which had no related instruction had a higher opinion of work than the groups which had related instruction. The adjusted means for the two levels were 72.35 and 69.29 respectively. Other adjusted and unadjusted means are given in Table VII. The F values for the year factor and the work experience x year interaction showed trends toward significance ($p < .25$). The adjusted means for years one, two, and three are 69.73, 72.21, and 70.51 respectively.

TABLE VI

ANALYSIS OF COVARIANCE SUMMARY TABLE FOR THE WORK OPINION INVENTORY

Source of Variation	Sum of Squares	DF	Mean Square	F
Between Subjects	405.565	18		
Related Instruction	117.865	1	117.865	6.507
Work Experience	6.326	1	6.326	0.349
RI x WE	9.676	1	9.676	0.534
Error (between)	271.698	15	18.113	
Within Subjects	716.936	37		
Year	59.152	2	29.576	1.604
RI x Year	23.214	2	11.607	0.629
WE x Year	66.281	2	33.141	1.797
RI x WE x Year	33.441	2	16.721	0.907
Error (within)	534.848	29	18.443	
Total	1122.501	55		

TABLE VII

ADJUSTED AND UNADJUSTED MEANS FOR THE WORK OPINION INVENTORY

Adjusted Means
Year

Treatment	1965-66	1966-67	1967-68	Mean
Control	72.98	71.89	71.94	72.27
Work Experience	71.44	74.57	71.26	72.42
Related Instruction	70.26	71.50	68.39	70.05
WE and RI	64.26	70.89	70.46	68.54
Mean	69.73	72.21	70.51	70.82

Unadjusted Means
Year

Treatment	1965-66		1966-67		1967-68	
	Pre	Post	Pre	Post	Pre	Post
Control	73.02	73.78	74.00	73.33	71.38	71.68
Work Experience	70.22	70.42	73.94	75.98	73.32	72.26
Related Instruction	71.80	70.27	70.90	70.92	71.07	67.92
WE and RI	72.42	64.67	69.88	69.65	69.42	68.92

The results of the analysis of covariance on the post-test scores of the Off-Farm Agricultural Occupations Opinion Inventory are given in Table VIII. The adjusted and unadjusted means are presented in Table IX. There were two F values that were significant at the .10 level. One of these was for the Related Instruction x Work Experience x Years interaction. Because that F value was significant, the significant F value for the Related Instruction x Years interaction has little meaning. The F value for the Related Instruction factor showed a trend toward significance ($p<.25$) but this also has little meaning due to the significant three-way interaction.

TABLE VIII

ANALYSIS OF COVARIANCE SUMMARY TABLE FOR THE OFF-FARM AGRICULTURAL OCCUPATIONS OPINION INVENTORY

Source of Variation	Sum of Squares	DF	Mean Square	F
Between Subjects	1001.288	18		
Related Instruction	160.324	1	160.324	2.865
Work Experience	1.392	1	1.392	0.025
RI x WE	0.186	1	0.186	0.003
Error (between)	839.386	15	55.959	
Within Subjects	1913.052	37		
Year	4.956	2	2.478	0.055
RI x Year	287.898	2	143.949	3.215
WE x Year	42.006	2	21.003	0.469
RI x WE x Year	279.910	2	139.955	3.126
Error (within)	1298.282	29	44.768	
Total	2914.340	55		

TABLE IX

ADJUSTED AND UNADJUSTED MEANS FOR THE OFF-FARM AGRICULTURAL OCCUPATIONS OPINION INVENTORY

	Adjusted Means Year			
Treatment	1965-66	1966-67	1967-68	Mean
Control	88.15	86.28	84.54	86.32
Work Experience	87.55	78.59	91.66	85.94
Related Instruction	80.43	84.47	83.47	82.79
WE and RI	82.33	86.56	78.68	82.52
Mean	84.61	83.97	84.59	84.39

	Unadjusted Means Year					
Treatment	1965-66		1966-67		1967-68	
	Pre	Post	Pre	Post	Pre	Post
Control	82.48	85.40	87.52	87.60	88.47	86.63
Work Experience	83.52	85.64	89.00	81.12	89.98	94.98
Related Instruction	91.90	85.30	86.60	85.05	91.32	87.87
WE and RI	76.92	75.07	81.02	82.63	81.82	75.40

The analysis of these three measures seemed to reveal little evidence concerning the most effective way to educate high school students for off-farm agricultural occupations. The only F value significant at the .05 level revealed that subjects with no related instruction scored higher on the Work Opinion Inventory than did those with related instruction. On all three measures, the group which had related instruction and work experience had the lowest score of all four treatment groups but the differences were not significant.

Results of the Follow-Up

Of particular interest in the present investigation was a follow-up study of the students who were in one of the four treatment groups in the off-farm agriculture occupations phase. Although the achievement of students, presented earlier in this chapter, presented valuable insights regarding the effectiveness of one of the four treatment groups in preparing students for off-farm agricultural occupations, it was felt by the researchers that important information could be obtained by a study of the employment status of students following graduation from high school. The three classes under investigation were students in the graduating classes of 1966, 1967 and 1968. A follow-up study was conducted each year; consequently, data were collected for three years on the class of 1966, for two years on the class of 1967 and for one year on the class of 1968. Over the four year period teacher turnover occurred in 15 of the 22 schools involved in the study. This high degree of turnover caused considerable difficulty for the researchers in obtaining the follow-up data. New teachers had to spend considerable time trying to locate students who had graduated one, two or three years prior to their arrival at the school. Consequently, the teachers were unable to obtain any information about some students and very limited data on other students. Thus, not all follow-up measures were analyzed in this research report. Four measures were used in gathering data for the follow-up phase of the study. These measures were (1) employment status, (2) weekly salary, (3) hours of employment per week, and (4) extent of job satisfaction if employed. The researchers felt that the first measure, employment status, was the most meaningful source of information. Consequently, primary attention will be focused on the employment status of students throughout this section of the report.

Tables X and XI present information concerning the number of students involved in the follow-up phase of the study. It may be noted in Table X that a total of 311 students were involved in this phase of the study.

The 311 students constituted the group of subjects in the classes of 1966, 1967, and 1968 who fulfilled the requirements of one of the four treatments.

Table X further revealed that during the three year period 25.4 percent of the students received only related instruction in off-farm agricultural occupations, 15.1 percent were involved in only work experience training, 10.9 percent received both job related instruction and work experience on the job and 48.6 percent were taught a traditional vocational agriculture course of instruction. The 48.6 percent served as a control group for the off-farm agricultural occupations phase of the study. As may be noted in Table X, considerable differences existed in the number of students involved in each phase of the study. Data in Table XI show the number of students in each treatment group by years. For the work experience only and the control groups, it may be noted that enrollment remained relatively consistent over the three year period. However, the related instruction group showed a rather distinct decline in enrollment from 33.3 percent of the sample in 1966 to 16.7 percent in 1968. The combination of related instruction and work experience increased from 6.9 percent in 1966 to 14.4 percent in 1968. Examination of Table XI also reveals that the number of students involved in the yearly analysis ranged from a high of 119 in 1967 to a low of 90 in 1968.

TABLE X

NUMBER OF STUDENTS IN EACH TREATMENT GROUP IN THE OFF-FARM AGRICULTURAL OCCUPATIONS PHASE OF THE STUDY

Treatment Group	Number of Students	Percent of Total
Related Instruction	79	25.4
Work Experience	47	15.1
Combination (RI & WE)	34	10.9
Control	151	48.6
Total	311	100.0

TABLE XI

TOTAL NUMBER OF STUDENTS EACH YEAR IN EACH TREATMENT GROUP IN THE OFF-FARM AGRICULTURAL OCCUPATIONS PHASE OF THE STUDY

Treatment Group	Distribution of Students					
	1966		1967		1968	
	N	Percent	N	Percent	N	Percent
Related Instruction	34	33.3	30	25.2	15	16.7
Work Experience	18	17.6	14	11.8	15	16.7
Combination (RI & WE)	7	6.9	14	11.8	13	14.4
Control	43	42.2	61	51.3	47	52.2
Total	102	100.0	119	100.1	90	100.0

The data presented in Tables XII through XV provide information concerning the initial employment status of students in each of the four treatment groups. The job classification scheme involved seven categories. The first job category was referred to as the off-farm agricultural occupations section. This category was of primary interest in the study because the central problem was aimed at exploring the most effective teaching procedure for preparing students to enter agricultural occupations other than farming. The researchers interpreted the meaning of an agricultural occupation other than farming to be in accordance with the definition described earlier in this report. A jury of agricultural educators was used each year to determine if the student's employment fit the category of an off-farm agricultural occupation. The jury was instructed to place students in this category if they were engaged in the supply, sales, distribution or service of agricultural products directly related to the farm or farm home, and, if the jury felt that agricultural knowledges and skills were essential for holding the job. The researchers attempted to provide a rather strict interpretation to the off-farm agricultural occupation job category.

The second category was referred to as a non off-farm agricultural occupation. All jobs other than off-farm agricultural occupations were included in this category. Thus, farming was considered a non off-farm agricultural occupation and individuals engaged in farming were placed in this category. No attempt was made in this report to study the employment trends of students engaged in farming.

Category three included all students enrolled in colleges and universities. The fourth category included all students in area trade or vocational schools as well as business schools. The fifth category was developed to reflect the number of students entering military service. Category six involved identifying students who were unemployed. Due to the large teacher turnover, category seven had to be developed to provide an accounting for students who had migrated from the community and were not available for the follow-up study. Despite the high degree of teacher turnover, only a limited number of students were lost in the follow-up procedure.

One note of caution should be observed when interpreting the data from the tables presented in this section. Quite frequently only one or two students are involved in a particular treatment group and job classification cell; consequently, group comparisons must be treated with a great amount of caution and may actually be somewhat misleading.

In Table XII it may be noted that 102 students were included in the initial follow-up of the class of 1966. There were 14 students employed in off-farm agricultural occupations and 66 in occupations other than off-farm agricultural occupations. Eleven students entered the military service.

Table XIII shows 15 students initially employed in agricultural occupations other than farming and 73 in all other occupations from the total of 119 students in the class of 1967. Only six students entered the military service while 20 students went to post-secondary schools.

In Table XIV, it can be noted that 25 students entered off-farm agricultural occupations compared with 54 who entered all other occupations. Seven students from the total of 90 in the class of 1968 entered military service.

Table XV reveals that for all three years 11 of the 79 students in the related instruction treatment, or 13.9 percent; 14 of the 47 students in the work experience treatment, or 29.8 percent; 12 of the 34 students in the combination treatment, or 35.3 percent; and 17 of the 151 students in the control group, or 11.3 percent, entered off-farm agricultural occupations. The percentages seem to indicate that the work experience and the work experience and related instruction treatments are better at making students aware of off-farm agricultural occupations. However, many students in these two treatments probably remained in the same position in which they received work experience as a student.

TABLE XII

FREQUENCY DISTRIBUTION OF THE INITIAL EMPLOYMENT OF STUDENTS IN THE CLASS OF 1966

Treatment Group	Job Classification*														Total	
	1		2		3		4		5		6		7			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	5	4.9	23	22.5	0	0.0	2	2.0	4	3.9	0	0.0	0	0.0	34	33.3
Work Experience	3	2.9	9	8.8	0	0.0	2	2.0	3	2.9	0	0.0	1	1.0	18	17.6
Combination (RI & WE)	1	1.0	2	2.0	0	0.0	1	1.0	1	1.0	1	1.0	1	1.0	7	6.9
Control	5	4.9	32	31.4	0	0.0	1	1.0	3	2.9	2	2.0	0	0.0	43	42.2
Total	14	13.7	66	64.7	0	0.0	6	6.0	11	10.7	3	3.0	2	2.0	102	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

TABLE XIII

FREQUENCY DISTRIBUTION OF THE INITIAL EMPLOYMENT OF STUDENTS IN THE CLASS OF 1967

Treatment Groups	Job Classification*															
	1		2		3		4		5		6		7		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	3	2.5	20	16.8	2	1.7	3	2.5	0	0.0	1	0.8	1	0.8	30	25.1
Work Experience	3	2.5	10	8.4	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	14	11.7
Combination (RI & WE)	4	3.4	6	5.0	0	0.0	3	2.5	0	0.0	0	0.0	1	0.8	14	11.7
Control	5	4.2	37	31.1	6	5.0	6	5.0	5	4.2	2	1.7	0	0.0	61	51.2
Total	15	12.6	73	61.3	8	6.7	12	10.0	6	5.0	3	2.5	2	1.6	119	99.7

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

TABLE XIV

FREQUENCY DISTRIBUTION INITIAL EMPLOYMENT OF STUDENTS IN THE CLASS OF 1968

	Job Classification*															
Treatment Groups	1		2		3		4		5		6		7		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	3	3.3	9	10.0	0	0.0	1	1.1	0	0.0	0	0.0	2	2.2	15	16.6
Work Experience	8	8.9	7	7.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	16.7
Combination (RI & WE)	7	7.8	4	4.4	1	1.1	0	0.0	1	1.1	0	0.0	0	0.0	13	14.4
Control	7	7.8	34	37.8	0	0.0	0	0.0	6	6.7	0	0.0	0	0.0	47	52.3
Total	25	27.8	54	60.0	1	1.1	1	1.1	7	7.8	0	0.0	2	2.2	90	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

TABLE XV

FREQUENCY DISTRIBUTION OF THE INITIAL EMPLOYMENT OF STUDENTS FOR ALL THREE CLASSES

Treatment Groups	Job Classification*															
	1		2		3		4		5		6		7		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	11	3.5	52	16.7	2	0.6	6	1.9	4	1.3	1	0.3	3	1.0	79	25.3
Work Experience	14	4.5	26	8.4	0	0.0	2	0.6	4	1.3	0	0.0	1	0.3	47	15.1
Combination (RI & WE)	12	3.9	12	3.9	1	0.3	4	1.3	2	0.6	1	0.3	2	0.6	34	10.9
Control	17	5.5	103	33.1	6	1.9	7	2.3	14	4.5	4	1.3	0	0.0	151	48.6
Total	54	17.4	193	62.1	9	2.8	19	6.1	24	7.7	6	1.9	6	1.9	311	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

Table XVI presents the mean weekly salary for subjects in both off-farm agricultural occupations and non off-farm agricultural occupations. It can be seen that the mean salaries across all three years are almost identical.

Table XVII presents the mean job satisfaction scores for subjects in both off-farm agricultural occupations and non off-farm agricultural occupations. Again it can be seen that the mean scores across the two years that are given are almost identical. Due to a change in the time of follow-ups, the job satisfaction scores were not available for the 1968 class.

The number of subjects entering and remaining in off-farm agricultural occupations over a period of one year is given in Table XVIII. It can be seen that there were losses from the beginning of the year to the end for each of the three years. It must be kept in mind that some of the students left off-farm agricultural occupations to enter the military service or post-secondary schools while others entered off-farm agricultural occupations during that period of time.

Table XIX shows the employment status of the 1966 class one year after graduation. In comparing these results with Table XII, initial employment, it can be seen that there is a marked decrease in the number of persons in non off-farm agricultural occupations and definite increases in the areas of post-secondary education and military service.

In comparing the results of Tables XX and XIII, the employment status of 1967 class one year after graduation and their initial employment, the trends stated for the class of 1966 hold true for the class of 1967.

Table XXI presents the employment status of the 1968 class one year after graduation. In comparing these results with Table XIV, initial employment, it can be noted that there is a marked decrease in the number of persons who are employed and comparable increases in the categories of post-secondary education and military service.

Table XXII presents the employment status of students for all three years one year after graduation. These results can be compared with the initial employment status given in Table XV. There were only 25 persons in off-farm agricultural occupations one year after graduation compared to 54 persons initially employed in this area. There were only 87 persons in non off-farm agricultural occupations compared to 193 persons initially employed. These sharp decreases can be attributed to equally sharp increases from nine to 58 attending colleges or universities, from 19 to 66 attending trade or business schools, and from 24 to 62

TABLE XVI

COMPARISON OF THE MEAN WEEKLY SALARY OF STUDENTS INITIALLY EMPLOYED IN OFF-FARM AGRICULTURAL OCCUPATIONS AND THOSE EMPLOYED IN NON OFF-FARM AGRICULTURAL OCCUPATIONS IN EACH TREATMENT GROUP

	Off-Farm Agricultural Occupations						Non Off-Farm Agricultural Occupations					
	1966		1967		1968		1966		1967		1968	
Treatment Group	N	Mean Salary	N	Mean Salary	N	Mean Salary	N	Mean Salary	N	Mean Salary	N	Mean Salary
Related Instruction	5	$74	3	$73	3	$70	23	$66	20	$72	9	$63
Work Experience	3	65	3	81	8	60	9	70	10	56	7	46
Combination (RI & WE)	1	68	4	55	7	72	2	72	6	75	4	69
Control	5	68	5	65	7	63	32	72	37	71	34	65
Total	14	70	15	67	25	65	66	69	73	70	54	63
Grand Total	N=54	Mean Salary=$67					N=193	Mean Salary=$68				

TABLE XVII

COMPARISON OF THE JOB SATISFACTION OF STUDENTS INITIALLY EMPLOYED IN OFF-FARM AGRICULTURAL OCCUPATIONS AND THOSE EMPLOYED IN NON OFF-FARM AGRICULTURAL OCCUPATIONS IN EACH TREATMENT GROUP

	Off-Farm Agricultural Occupations						Non Off-Farm Agricultural Occupations					
	1966		1967		1968		1966		1967		1968	
Treatment Group	N	Mean Score	N	Mean Score	N	Mean Score	N	Mean Score	N	Mean Score	N	Mean Score
Related Instruction	5	47	3	39	3	--	23	46	20	48	9	--
Work Experience	3	51	3	39	8	--	9	48	10	50	7	--
Combination (RI & WE)	1	57	4	46	7	--	2	49	6	42	4	--
Control	5	48	5	44	7	--	32	46	37	47	34	--
Total	14	49	15	43	25	--	66	46	73	47	54	--
Grand Total		N=29	Mean Score=46					N=139	Mean Score=47			

TABLE XVIII

NUMBER OF STUDENTS ENTERING AND REMAINING IN OFF-FARM AGRICULTURAL OCCUPATIONS AFTER ONE YEAR OF EMPLOYMENT

Treatment Group	Class of 1966				Class of 1967				Class of 1968			
	Initial	Initial Number Remaining	Entering	End Of Year Total	Initial	Initial Number Remaining	Entering	End Of Year Total	Initial	Initial Number Remaining	Entering	End Of Year Total
Related Instruction	5	1	2	3	3	1	3	4	3	0	1	1
Work Experience	3	1	0	1	3	0	1	1	8	3	0	3
Combination (RI & WE)	1	0	0	0	4	2	2	4	7	0	0	0
Control	5	2	3	5	5	0	0	0	7	1	2	3
Total	14	4	5	9	15	3	6	9	25	4	3	7
Change after one year			-5				-6				-18	

TABLE XIX

FREQUENCY DISTRIBUTION OF THE EMPLOYMENT STATUS OF STUDENTS IN THE CLASS OF 1966 ONE YEAR AFTER GRADUATION

	Job Classification*															
Treatment	1		2		3		4		5		6		7		Total	
Groups	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	3	2.9	10	9.8	2	2.0	5	4.9	13	12.7	0	0.0	1	1.0	34	33.3
Work Experience	1	1.0	7	6.9	2	2.0	1	1.0	5	4.9	0	0.0	2	2.0	18	17.6
Combination (RI & WE)	0	0.0	0	0.0	1	1.0	3	2.9	2	2.0	0	0.0	1	1.0	7	6.9
Control	5	4.9	16	15.7	4	3.9	4	3.9	14	13.7	0	0.0	0	0.0	43	42.2
Total	9	8.8	33	32.4	9	8.9	13	12.7	34	33.3	0	0.0	4	4.0	102	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

TABLE XX

FREQUENCY DISTRIBUTION OF THE EMPLOYMENT STATUS OF STUDENTS IN THE CLASS OF 1967 ONE YEAR AFTER GRADUATION

Treatment Groups	Job Classification*															
	1		2		3		4		5		6		7		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	4	3.4	8	6.7	5	4.2	7	5.9	1	.8	1	.8	4	3.4	30	25.2
Work Experience	1	.8	5	4.2	2	1.7	2	1.7	4	3.4	0	0.0	0	0.0	14	11.8
Combination (RI & WE)	4	3.4	4	3.4	1	.8	4	3.4	0	0.0	0	0.0	1	.8	14	11.8
Control	0	0.0	11	9.2	22	18.5	14	11.8	11	9.2	2	1.7	1	.8	61	51.2
Total	9	7.6	28	23.5	30	25.2	27	22.8	16	13.4	3	2.5	6	5.0	119	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

TABLE XXI

FREQUENCY DISTRIBUTION OF THE EMPLOYMENT STATUS OF STUDENTS IN THE CLASS OF 1968 ONE YEAR AFTER GRADUATION

Treatment	Job Classification*															
	1		2		3		4		5		6		7		Total	
Group	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	1	1.1	6	6.7	5	5.6	3	3.3	0	0.0	0	0.0	0	0.0	15	16.7
Work Experience	3	3.3	5	5.6	4	4.4	2	2.2	1	1.0	0	0.0	0	0.0	15	16.7
Combination (RI & WE)	0	0.0	1	1.1	1	1.1	6	6.7	5	5.6	0	0.0	0	0.0	13	14.4
Control	3	3.3	13	14.4	10	11.1	15	16.7	6	6.7	0	0.0	0	0.0	47	52.2
Total	7	7.8	25	27.8	20	22.2	26	28.9	12	13.3	0	0.0	0	0.0	90	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

2

TABLE XXII

FREQUENCY DISTRIBUTION OF THE EMPLOYMENT STATUS OF STUDENTS IN ALL THREE CLASSES ONE YEAR AFTER GRADUATION

Treatment Group	Job Classification* 1 N	%	2 N	%	3 N	%	4 N	%	5 N	%	6 N	%	7 N	%	Total N	%
Related Instruction	8	2.6	25	8.0	11	3.5	15	4.8	14	4.5	1	0.3	5	1.6	79	25.3
Work Experience	5	1.6	17	5.5	8	2.6	5	1.6	10	3.2	0	0.0	2	0.6	47	15.1
Combination (RI & WE)	4	1.3	5	1.6	3	1.0	13	4.2	7	2.3	0	0.0	2	0.6	34	10.9
Control	8	2.6	40	12.9	36	11.6	33	10.6	31	10.0	2	0.6	1	0.3	151	48.6
Total	25	8.0	87	28.0	58	18.6	66	21.2	62	20.0	3	1.0	10	3.2	311	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

in the military service. These changes vividly show the instability of the employment of recently graduated males.

Table XXIII presents the mean weekly salaries of students employed in off-farm agricultural occupations and non off-farm agricultural occupations one year after graduation. It should be noted again that this does not necessarily represent the mean salaries of individuals who have been employed in the same position for a full year. Many individuals changed positions one or more times during the first year after graduation from high school. The mean weekly salaries of individuals employed in off-farm agricultural occupations and non off-farm agricultural occupations were $86 and $79, respectively.

The results presented in Table XXIV, job satisfaction scores of subjects in off-farm agricultural occupations and non off-farm agricultural occupations one year after graduation, can be compared with the results in Table XVII, the initial job satisfaction scores for subjects in the same two categories. However, it should be kept in mind that the job satisfaction scores given in Table XXIV do not necessarily represent the satisfaction with a job after a complete year of employment on that job. Many of the subjects represented in Tables XVII and XXIV changed jobs and occupations during the year. The mean job satisfaction scores for the individuals employed in off-farm agricultural occupations and non off-farm agricultural occupations were nearly the same as they were at the time of initial employment. The mean scores were 49 and 47 respectively.

The results in Table XXV, the employment status of individuals in the class of 1966 two years after graduation, can be compared with the results in Table XIX, the employment status of the same group one year after graduation. There is very little difference between the job classification totals on the two tables. The employment status of individuals in the class of 1966 was much more stable for the second year after high school graduation than it was for the first year.

The employment status of subjects in the class of 1967 did not show the same stability. This can be seen by comparing the results of Table XIII, initial employment status, Table XX, employment status after one year, and Table XXVI, employment status after two years. It can be seen that the number of subjects in off-farm agricultural occupations continued to decrease and the number of individuals in the military service continued to increase. The number of individuals in non off-farm agricultural occupations first decreased and then increased. The number of individuals in colleges, universities, trade schools, and business schools first increased and then decreased.

TABLE XXIII

COMPARISON OF THE MEAN WEEKLY SALARIES OF STUDENTS EMPLOYED IN OFF-FARM AGRICULTURAL OCCUPATIONS AND NON OFF-FARM AGRICULTURAL OCCUPATIONS ONE YEAR AFTER GRADUATION

	Off-Farm Agricultural Occupations						Non Off-Farm Agricultural Occupations					
	1966		1967		1968		1966		1967		1968	
Treatment Group	N	Mean Salary	N	Mean Salary	N	Mean Salary	N	Mean Salary	N	Mean Salary	N	Mean Salary
Related Instruction	3	$82	4	$88	1	$90	10	$82	8	$85	6	$96
Work Experience	1	75	1	130	3	70	7	97	5	71	5	110
Combination (RI & WE)	0	0	4	96	0	0	0	0	4	70	1	0
Control	5	80	0	0	3	85	16	67	11	70	13	75
Total	9	80	9	96	7	78	33	77	28	75	25	88
Grand Total		N=25	Mean Salary=$86					N=86	Mean Salary=$79			

TABLE XXIV

COMPARISON OF THE JOB SATISFACTION OF STUDENTS EMPLOYED IN OFF-FARM AGRICULTURAL OCCUPATIONS AND NON OFF-FARM AGRICULTURAL OCCUPATIONS AFTER ONE YEAR OF EMPLOYMENT

	Off-Farm Agricultural Occupations						Non Off-Farm Agricultural Occupations					
	1966		1967		1968		1966		1967		1968	
Treatment Group	N	Mean Score	N	Mean Score	N	Mean Score	N	Mean Score	N	Mean Score	N	Mean Score
Related Instruction	3	51	4	50	1	34	10	48	8	49	6	46
Work Experience	1	55	1	46	3	57	7	50	5	53	5	50
Combination (RI & WE)	0	0	4	48	0	0	0	0	4	37	1	0
Control	5	34	0	0	3	56	16	49	11	47	13	39
Total	9	46	9	49	7	53	33	49	28	47	25	44
Grand Total		N=25		Mean Score=49					N=86			Mean Score=47

TABLE XXV

FREQUENCY DISTRIBUTION OF THE EMPLOYMENT STATUS OF STUDENTS IN THE CLASS OF 1966 TWO YEARS AFTER GRADUATION

	Job Classification*															
Treatment	1		2		3		4		5		6		7		Total	
Group	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	2	2.0	15	14.7	3	2.9	3	2.9	10	9.8	0	0.0	1	1.0	34	33.3
Work Experience	0	0.0	9	8.8	2	2.0	0	0.0	5	4.9	0	0.0	2	2.0	18	17.6
Combination (RI & WE)	1	1.0	0	0.0	1	1.0	2	2.0	2	2.0	0	0.0	1	1.0	7	6.9
Control	4	3.9	13	12.7	4	3.9	5	4.9	15	14.7	0	0.0	2	2.0	43	42.2
Total	7	6.9	37	36.3	10	9.8	10	9.8	32	31.4	0	0.0	6	5.9	102	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

TABLE XXVI

FREQUENCY DISTRIBUTION OF THE EMPLOYMENT STATUS OF STUDENTS IN THE CLASS OF 1967 TWO YEARS AFTER GRADUATION

Treatment Group	Job Classification*															
	1		2		3		4		5		6		7		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	1	0.8	12	10.1	4	3.4	1	0.8	12	10.1	0	0.0	0	0.0	30	25.2
Work Experience	1	0.8	5	4.2	1	0.8	2	1.7	5	4.2	0	0.0	0	0.0	14	11.8
Combination (RI & WE)	1	0.8	6	5.0	2	1.7	4	3.4	1	0.8	0	0.0	0	0.0	14	11.8
Control	1	0.8	12	10.0	12	10.1	11	9.2	19	16.0	0	0.0	6	5.0	61	51.3
Total	4	3.4	35	29.4	19	16.0	18	15.1	37	31.1	0	0.0	6	5.0	119	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

The final table presents the employment status of the subjects in the class of 1966 three years after graduation. Again, these results can be compared with the results in Tables XII, XIX, and XXV. These tables present the employment status of the same subjects initially, one year after graduation, and two years after graduation, respectively. The number of persons in off-farm agricultural occupations remained fairly stable after the subjects were out of school for one year. The number of persons in non off-farm agricultural occupations decreased 50 percent during the first year and then increased somewhat each of the next two years. The number of persons in post-secondary schools increased markedly during the first year, remained fairly stable during the second year, and decreased sharply during the third year. The number of individuals in the military service increased sharply during the first year and then remained fairly stable for the next two years.

Analysis of the Principles Phase

The analysis of this phase of the project had two major parts, each of which had the same purpose: to determine which of two approaches was better for the instruction of high school vocational agriculture students. Treatment 1 involved schools which had not offered vocational agriculture before the implementation of this investigation and whose teachers taught vocational agriculture using the principles approach. Treatment 2 was composed of schools which offered vocational agriculture before the beginning of this study and whose teachers used the principles approach in their teaching. Treatment 3 involved schools which had vocational agriculture previous to the implementation of the investigation and whose teachers used their own traditional approach to teaching vocational agriculture. Thus, the schools in Treatment 3 served as a control group.

In the principles phase of the study, the first of the two major parts under examination was the analysis of the three separate yearly achievement tests. This examination was carried out by the use of three analyses of covariance on the post-test scores with the pre-test scores used as covariates. The pre-test scores were the only meaningful measures available for use as covariates.

The instrument for evaluating the achievement of students in the 1965-66 school year was the Test on the Principles of Plant and Animal Science. The analysis was carred out on all 24 schools in the project. An F value of

TABLE XXVII

FREQUENCY DISTRIBUTION OF THE EMPLOYMENT STATUS OF STUDENTS IN THE CLASS OF 1966 THREE YEARS AFTER GRADUATION

Treatment Group	Job Classification*															
	1		2		3		4		5		6		7		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Related Instruction	3	3.0	14	13.9	1	1.0	1	1.0	15	14.9	0	0.0	0	0.0	33	32.7
Work Experience	1	1.0	8	7.9	1	1.0	0	0.0	7	6.9	0	0.0	1	1.0	18	17.8
Combination (RI & WE)	2	2.0	0	0.0	1	1.0	0	0.0	4	4.0	0	0.0	0	0.0	7	6.9
Control	3	3.0	25	24.8	2	2.0	0	0.0	11	10.9	0	0.0	2	2.0	43	42.6
Total	9	8.9	46	45.5	5	5.0	1	1.0	37	36.6	0	0.0	3	3.0	101	100.0

*Job Classification
1. Off-Farm Agricultural Occupation
2. Non Off-Farm Agricultural Occupation
3. College or University
4. Trade or Business School
5. Military Service
6. Unemployed
7. Unknown

6.535 was obtained which was significant at the .01 level. Consequently, Sheffe simultaneous confidence intervals were constructed for individual comparisons. Sheffe tests were used because of their flexibility in allowing more than just simple comparisons between pairs of means. However, it should be pointed out that they are more conservative than other such tests. The Sheffe confidence intervals revealed that there were no significant differences between treatments 1 and 2 and between treatments 1 and 3. There was, however, a significant difference at the .01 level between treatments 2 and 3 with treatment 2, a principles treatment, having the higher mean. A confidence interval was also constructed for the difference between the combination of treatments 1 and 2 and treatment 3. This confidence interval represented a comparison between the principles approach and the traditional approach. This comparison showed that the combination of treatments 1 and 2, the two principles treatments, was significantly better than treatment 3 at the .05 level. The pre-test and post-test means, the adjusted means, and the standard deviations for the Test on the Principles of Plant and Animal Science are given in Table XXVIII.

TABLE XXVIII

ADJUSTED AND UNADJUSTED MEANS AND STANDARD DEVIATIONS FOR THE TEST ON THE PRINCIPLES OF PLANT AND ANIMAL SCIENCE, 1965-66

	Treatment							
	1		2		3		Total Sample	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	28.36	40.14	28.26	42.87	31.46	38.16	29.36	40.39
S.D.	5.58	5.71	3.70	6.08	5.45	7.22	5.00	6.40
Adjusted Mean	41.12		43.95		36.11		40.39	

Mechanics principles comprised the course of study for the experimental approach for the 1966-67 school year. The achievement test used that year was the Test on Principles of Mechanics. The analysis involved data from only 22 schools because two schools dropped from the project after the first year. The F value from the analysis of covariance was 3.934 which was significant at the .05 alpha level. Again, Sheffe confidence intervals were constructed. There were no significant differences between treatments 1 and 2, 1 and 3, or 2 and 3. However, the combination of treatments 1 and 2 was significantly better than treatment 3 at the .05 level. This comparison would indicate that students taught with the principles approach had significantly higher achievement test scores than those students taught in the traditional manner. The adjusted means, unadjusted means, and standard deviations for the Test on Principles of Mechanics are given in Table XXIX.

TABLE XXIX

ADJUSTED AND UNADJUSTED MEANS AND STANDARD DEVIATIONS FOR THE TEST ON PRINCIPLES OF MECHANICS, 1966-67

	Treatment							
	1		2		3		Total Sample	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	38.10	45.20	37.34	45.30	36.94	39.40	37.49	43.39
S.D.	5.09	5.66	3.02	6.33	4.30	3.26	4.10	5.74
Adjusted Mean	44.70		45.42		39.85		43.39	

The evaluation instrument for the 1967-68 school year was the Test on Agricultural Management and Marketing Principles. The analysis again involved the 22 remaining schools. The F value for the analysis of covariance was 0.007 which was not significant. Therefore, no simultaneous confidence intervals were constructed. The adjusted means, unadjusted means, and standard deviations for the Test on Agricultural Management and Marketing Principles are presented in Table XXX.

TABLE XXX

ADJUSTED AND UNADJUSTED MEANS AND STANDARD DEVIATIONS FOR THE TEST ON AGRICULTURAL MANAGEMENT AND MARKETING PRINCIPLES, 1967-68

	Treatment							
	1		2		3		Total Sample	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	42.40	46.06	43.63	47.56	38.74	43.14	41.63	45.61
S.D.	8.82	13.07	5.02	8.71	10.19	10.79	8.19	10.73
Adjusted Mean	45.34		45.69		45.84		45.61	

It should be pointed out that the three tests discussed above were not constructed to deal only with the principles approach. They were not intended to be biased toward the principles approach even though the word "Principles" is present in each title. This was done merely for identification purposes. The sample for the item analysis for each of the tests consisted of vocational agriculture students who had been taught in a traditional manner. Items which were greatly biased toward the principles approach probably did not fare well; consequently, it is likely that they were eliminated from the final form.

In summary, the first part of the analysis of the principles phase indicates that the principles approach was more effective in producing a positive change in agricultural achievement test scores for the 1965-66 and the 1966-67 school years. The principles approach was at least as effective as the traditional approach for the 1967-68 school year.

The second major part of this phase of the project involved the analysis of the scores from the Agricultural Achievement Test. This test consists of four subtests: Plant and Soil Science, Mechanics, Animal Science, and Management. These subtests are labeled Part I, Part II, Part III, and Part IV, respectively. This test was administered only at the close of the 1967-68 school year. Those students who had been in one of the three treatment groups for all three years of the investigation were used in this analysis. Three schools had no students which fulfilled this requirement. Thus, 21 schools, seven in each treatment group, were involved in this analysis.

A computer program which performed a step-wise multiple regression was used to select a possible covariate or possible covariates for the four subtests. The following variables were considered as possible covariates:

1. Student attitude toward the teacher and his method.
2. California Test of Mental Maturity - Short Form, Language Score.
3. California Test of Mental Maturity - Short Form, Non-Language Score.
4. California Test of Mental Maturity - Short Form, Total Score.
5. Bennett Test of Mechanical Comprehension Score.
6. Percentage of the students living on a farm.

7. Number of years of study in vocational agriculture in high school.

8. Rank in graduating class.

The best possible covariates for Part I were the California Test of Mental Maturity Language and Total Scores and rank in graduating class. The best covariate for Part II was the California Test of Mental Maturity Total Score, while the best covariate for Parts III and IV was the California Test of Mental Maturity Language Score. From these results, the Language Score on the California Test of Mental Maturity - Short Form was selected as the single covariate. This measure was significant at the .05 level on two subtests and at the .10 level on a third in the step-wise multiple regression procedure. Only one covariate was selected because of the small number of subjects (schools) involved.

Since the four subtests were administered to the same sample, a multivariate analysis of covariance was more appropriate than four univariate analyses (Morrison, 1967). The multivariate analysis provided an overall F test to determine if there were any significant differences among the treatments on any or all of the four subtests. The computed F value was 2.394 which was significant at the .05 level. Simultaneous confidence intervals were then constructed between all possible pairs of treatment means for all subtests (Morrison, 1967). None of the differences between pairs of means were significant at the .05 level.

At that point, a separate analysis of covariance was computed on each of the four subtests since an overall significant F value had been obtained. The F values for Part I, Plant and Soil Science, and Part III, Animal Science, were not significant. However, on the analysis of Part II, Mechanics, an F value of 4.70 was obtained which was significant at the .05 level. In doing Sheffe contrasts, it was found that treatment 2, a principles group, was significantly higher than treatment 3, the control group. On Part IV, Management, a significant F value of 4.54 was also obtained which was significant at the .05 level. The Sheffe contrasts revealed that again treatment 2 was significantly higher than treatment 3. It was also found that the combination of treatments 1 and 2, the two principles groups, was significantly higher than treatment 3, the control group. The unadjusted means, standard deviations, and adjusted means for the four subtests of the Agriucltural Achievement Test are presented in Tables XXXI and XXXII.

TABLE XXXI

MEANS AND STANDARD DEVIATIONS FOR THE AGRICULTURAL ACHIEVEMENT TEST AND THE COVARIATE

Treatment		Part I	Part II	Part III	Part IV	CTMM-L Raw Score
1	Mean	26.64	27.53	26.86	23.47	27.27
	S.D.	8.30	8.18	5.76	7.75	7.18
2	Mean	33.00	34.09	30.36	29.06	31.19
	S.D.	3.32	5.06	5.14	6.31	4.60
3	Mean	30.56	28.09	28.60	24.10	34.86
	S.D.	3.95	3.16	3.46	4.13	2.86
Total Sample	Mean	30.07	29.90	28.60	25.54	31.10
	S.D.	5.99	6.33	4.86	6.42	5.86

TABLE XXXII

ADJUSTED MEANS FOR THE AGRICULTURAL ACHIEVEMENT TEST

Treatment	Part I	Part II	Part III	Part IV	Mean
1	28.13	30.01	28.87	26.55	28.39
2	32.97	34.03	30.31	28.99	31.58
3	29.10	25.65	26.63	21.08	25.62
Total Sample	30.07	29.90	28.60	25.54	28.53

The analysis of the scores of the Agricultural Achievement Test supports the analysis of the other three achievement tests described earlier. It can be seen in Table XXXII that treatment 2 had the highest score consistently and that treatment 1 was higher than treatment 3, the control group, on three of the four subtests. On two of the subtests, treatment 2 was significantly higher than treatment 3 and on one of those subtests, the combination of treatments 1 and 2 was higher than treatment 3. This indicates that the principles approach was generally a more effective teaching method than the traditional method in terms of producing positive changes in performance on the Agricultural Achievement Test.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Chapter IV consists of two major parts: (1) a discussion of the problems encountered in the course of the investigation, and (2) a discussion of the findings, recommendations based on these findings, and the major accomplishments resulting from this investigation. While a discussion of the problems encountered in the study is a somewhat negative approach, it is necessary so that the findings may be interpreted in the proper light. It is also possible to gain valuable insights for further teaching programs or research by viewing the problems which appeared in this study.

Problems Encountered

There were a number of problems and obstacles involved with the off-farm agricultural occupations phase of the investigation. One of the most important problems was a lack of definitive dependent variables. The objective measures which were anlayzed statistically did not measure what the investigators wished to measure and the results were inconclusive. The data obtained from the follow-up of the students are useful; however, they are also somewhat inconclusive. Knowing the number of persons entering off-farm agricultural occupations does not indicate how well those persons have been trained to enter those occupations. The opinions of the teachers who participated in the study are helpful; but they were viewing the situation from a teacher's standpoint, not a student's point of view. Thus, this phase of the study was lacking in dependent measures which really measured a student's preparation and training for entry into an off-farm agricultural occupation. The problem of finding such a measure has no easy solution.

A second problem which had an effect on the results of this phase of the study involved the student entrance requirements for participating in the experimental group. The entrance requirements for admitting students into the program were not set forth by the research staff; therefore, each school determined these requirements. Some schools had no requirements and allowed anyone to participate. Other schools set up fairly stringent requirements. One school required a cumulative grade average of 85 percent in order to participate. This kind of discrepancy between schools might have had some effect on both objective and subjective measures in this study.

The problem which occurred most frequently and which caused the most concern to the investigators involved the small numbers of students actually fulfilling the requirements for the experimental treatment in most of the experimental schools. In order to fulfill the treatment requirements, a student had to study about an off-farm agricultural occupation in class, gain work experience in an off-farm agricultural occupation, or both. In some cases there were no students which fit these criteria. There were several different causes related to this problem. One such cause was that teachers had difficulty explaining the importance of and the need for such a program. The teachers also had difficulty in explaining that the work experience was to be a learning experience. One other reason for these difficulties was a lack of time on the teachers' part. Generally, they were involved in teaching and supervising their regular vocational agriculture programs as well as the off-farm agricultural occupations programs. Several teachers suggested that two vocational agriculture teachers in the school would alleviate much of this difficulty.

A second cause was the size of some of the participating communities. Several of the communities had only a limited number of off-farm agricultural businesses and, consequently, provided very few agriculturally related employment opportunities in which students could receive directed work experience.

The third cause is probably the most important of all. When the investigation was just getting underway, it was decided by the directors of the project that the experimental schools should be allowed to operate a diversified occupations program rather than just an off-farm agricultural occupations program. A diversified occupations program could involve study and/or work experience in any occupation that a student was interested in and/or could find actual work experience in. It was felt by the project directors that this type of program would be more acceptable to the experimental schools and would create more interest among the students. Thus, the off-farm agricultural occupations program was simply a part of the diversified occupations program in most of the experimental schools. The diversified occupations course provided teachers and school administrators with a great deal of flexibility in scheduling classes; however, many of the vocational agriculture teachers had difficulty finding materials for and coordinating the work of students in occupations unrelated to agriculture. A diversified occupations program does have its merits for a small community and several of the experimental schools have continued with generally successful programs after the close of the study. After the study was in progress, the investigators felt that the inclusion of the diversified occupations program took the emphasis away from off-farm agricultural occupations. The purpose of this study was to determine the best way to educate a student for entry into an off-farm agricultural occupation. If the experimental schools had been told that the program was to pertain only to agriculturally related occupations, more students would likely have been involved in this phase of the study. The teachers could have concentrated their efforts in this particular area and the investigation would have been strengthened.

The major problems concerning the principles phase of the project involved the teachers. First of all, many of the teachers felt that they had not been adequately prepared to teach using the principles approach. This problem is primarily the fault of the research staff. However, the staff had no way of knowing how much preparation was actually necessary for this type of teaching. It does appear, however, that adequate preparation was not provided.

The second problem is concerned with teacher understanding of the research design and cooperation with the research staff and their objectives. Again, part of this problem could have been remedied by giving the participating teachers a better understanding of research methods, in general, and of this investigation specifically. However, it did appear that part of the problem was caused by the attitudes of the teachers. Some teachers felt that the principles approach was inappropriate and, thus, used only those parts of the materials which fit in with their own methods of teaching. This was inexcusable for the purposes of the investigation.

In summary, a lack of definitive dependent variables and a lack of control over the behavior of the teachers were the two basic difficulties. There is no easy solution to the first and further work needs to be done. It is, of course, impossible to completely control the teachers' behavior; but the researchers felt that more uniformity of behavior was possible than was attained in this investigation.

Conclusions

The following statements concerning the off-farm agricultural occupations phase are based on the hypotheses stated in Chapter II.

The investigators failed to reject the hypotheses that there were no significant differences on the Test of General Information for Prospective Workers between any of the treatment factors.

The researchers also failed to reject the hypotheses that there were no significant differences on the Off-Farm Agricultural Occupations Opinion Inventory between any of the treatment factors.

There was a significant difference on the Work Opinion Inventory between the subjects receiving related instruction and those not receiving related instruction with the schools in the latter category having the higher scores. The investigators failed to reject the other null hypotheses concerned with the Work Opinion Inventory.

The results from the follow-up were not statistically analyzed; thus, the hypotheses concerned with the follow-up were neither accepted nor rejected.

The statistical analyses of the objective measures and the data from the follow-up of the students in the off-farm agricultural occupations phase of the study reveal little of significance. No conclusions concerning the various methods of preparing students for entry into off-farm agricultural occupations can be made from the results reported in Chapter III. However, it should be noted that, in terms of the analysis of the objective measures, the control group performed as well as the experimental treatment groups on the objective measures. The control group subjects received instruction only in vocational agriculture.

It is of interest and importance to consider the opinions, ideas, and criticisms of the teachers who participated in the study. Their subjective findings may well be the most valuable source of information for this phase of the investigation. In general, they felt that the best method for preparing students for entry into off-farm agricultural occupations was a combination of in-class instruction and directed work experience. Some felt that in addition to this combination, the student should also be required to enroll in vocational agriculture courses.

The teachers had difficulty finding training centers for the students that needed work experience. They felt that the program would be appropriate for larger communities where job opportunities would be better.

Several teachers recommended that two vocational agriculture teachers were necessary if a school has an off-farm agricultural occupations program as well as the traditional high school and adult vocational agriculture programs. They felt that this would alleviate the problems involved with finding materials and study guides and making periodic visits to the students on the job.

Several teachers suggested that a diversified occupations program was better for small schools and communities than just an off-farm agricultural occupations program. It could be better justified in terms of time and money. However, if the diversified occupations program is to operate successfully, it should be coordinated by all the vocational teachers or some one teacher trained for the position and not just the vocational agriculture teacher.

It was also suggested that in small communities where employment opportunities are limited, in-class study of an occupation without directed work experience might be the best approach. However, the State Department of Education of the State of Nebraska now requires work experience as part of the program if reimbursement is to be received. This requirement had been dropped for the experimental schools during the three years of the study.

The off-farm agricultural occupations phase involved only twelfth graders. A final suggestion worthy of mention was that the program could begin at the start of the second semester of the eleventh grade; and, thus, the summer employment the following summer could be in an off-farm agricultural occupation and could definitely be a learning experience.

The statements which follow are based on the hypotheses stated in Chapter II and are related to the principles phase of this study.

There were significant differences on the Test of Principles of Plant and Animal Science and on the Test on Principles of Mechanics between the schools using the principles approach and the schools not using the principles approach.

The investigators failed to reject the hypothesis that there was no significant difference on the Test on Agricultural Management and Marketing Principles between schools using the principles approach and the schools not using the principles approach.

There were significant differences on two of the four subtests of the Agricultural Achievement Test between the schools using the principles approach and the schools not using the principles approach.

In all cases where significant differences existed, the schools using the principles approach had higher test scores than the school which used the traditional approach.

Most of the results presented in regard to the principles phase of the study support the statement that the principles approach is better than the traditional approach for the learning of high school vocational agriculture subject matter. In all cases, the principles approach is as good as the traditional approach.

Teachers' opinions support these statements. Most of the teachers felt that the principles approach produced some improvement in their vocational agriculture curriculum from previous years. Most of them favor this approach for teaching vocational agriculture. They felt that school administrators, other teachers, and parents had positive reactions, in general, toward the new approach. They also stated that the students liked the new approach. An important point that the teachers made was that they did not feel well enough prepared to teach the principles approach with the undergraduate and/or graduate teaching methods courses and a special summer workshop which they had had.

Recommendations

From the analysis of the data in the present study, certain recommendations may be made for the curriculum worker in developing courses of study for students with an interest in agriculture in secondary schools. The investigators fully realize there may be other valid ways of interpreting the data from the present study. The recommendations made in this study are based on:

1. Conclusions from the statistical analysis of the data.
2. Observations of students by the research staff when making periodic visits to the schools.
3. Observations and insights gained by visiting with teachers throughout the three-year investigation.
4. Knowledge gained by consulting with school administrators and businessmen during supervisory visits to the school.

With these points in mind, the investigators offer the following recommendations:

1. In the examination of the most effective approach for preparing high school students for agricultural occupations other than farming, it is evident from the statistical data that none of the four approaches proved to be most effective. Consequently, the traditional vocational agriculture class is as effective a means of preparing students for agricultural occupations as the three experimental treatments used in this study. However, teachers expressed the best approach was a combination of work experience and related instruction. Thus, the investigators recommend the combination of work experience and related instruction due to the satisfaction expressed by the teachers. The statistical data does not discredit this approach; neither does it support this means of preparing students.
2. An off-farm agricultural occupations course has limited possibilities for on-the-job work experience in small rural communities, and consequently, schools should consider initiating a diversified occupations course or maintaining the regular vocational agriculture course of study as a means of preparing students for agricultural occupations other than farming.

3. An off-farm agricultural occupations course should have a cooperative occupational work experience phase because it may provide students with realistic experiences in the world-of-work.
4. If an off-farm agricultural occupations course is to be initiated in a school curriculum, the school administration should give serious consideration to employing an additional teacher to coordinate a meaningful learning experience for the students.
5. From the analysis of the data and research staff observations, the investigators recommend that high school students in vocational agriculture should be taught agricultural subject matter based on the principles approach. This recommendation is made with the condition that the teacher has received the proper pre-service or in-service educational program in teaching and implementing this teaching procedure.

Accomplishments

The accomplishments resulting from this investigation are many. Most of them can be classified as new curriculum material. However, one of the major accomplishments is the Agricultural Achievement Test, a four part nationally standardized general achievement test for high school vocational agriculture students. Standard score and percentile norms are available for tenth and twelfth grade students. It is hoped that the test will be published and available for general use by schools in the immediate future.

Evidence seems to indicate that a nationally standardized agricultural achievement test has considerable potential for evaluating programs of vocational agriculture. A national achievement test could provide a valuable measure for evaluating student performance in future research efforts.

The other major products are curriculum materials developed for the two phases of the investigation. The principles materials have attracted the attention of teachers and school administrators nationally as well as internationally. Agricultural subject matter based on principles of biological science, physical science and economics offer an entirely new vocational agriculture curriculum to teachers across the nation. The blending of discovery learning and problem-solving learning has resulted in students achieving at significantly higher levels than those taught agricultural subject matter in a traditional manner. The following materials were developed for the principles phase of the study:

1. Principles in Animal, Plant, and Soil Science
2. Principles in Agricultural Mechanics
3. Principles in Agricultural Marketing and Management.

Each of these curriculum guides is accompanied by Student Worksheets and a Teacher's Key.

Since teaching materials in the area of Off-Farm Agricultural Occupations were extremely limited at the inception of this study, considerable effort was made in developing individualized study guides for student use in the classroom.

The following materials were developed for the off-farm agricultural occupations phase of the study:

1. Agricultural Supply, Sales, and Service Occupations
   Part I: General Information
   Part II: Feed Sales and Service Occupations
   Part III: Fertilizer Sales and Service Occupations
   Part IV: Crop, Lawn and Garden Seeds Sales and Service Occupations
   Part V: Petroleum and Petroleum Products Sales and Service Occupations
   Each of these study guides is accompanied by Student Worksheets and a Teacher's Key.

2. Coordinator's Guide: A Syllabus for General Related Instruction for Off-Farm Agricultural and Diversified Occupations in Nebraska and accompanying Student Manual.

3. Tractor Repair and Maintenance Course of Study and accompanying Key.

One of the most rewarding and perhaps noteworthy aspects of the study was the involvement of efforts not only of the entire joint agricultural education staffs of the University and State Department of Education, but also committment of so large a number of public schools for the three year program--even before the treatment to be required of them was known--and some to the extent of establishing a new department.

In summary, the investigators are of the opinion that one of the major contributions of the present study was the development of the Agricultural Achievement Test and the teaching materials which organized agricultural subject matter on the "Principles Approach" along with the individual student study guides developed for the Off-Farm Agricultural Occupations. Another major contribution was the evidence obtained supporting the new vocational agriculture curriculum which involves the solving of agricultural problems through basic principles of biology, physics, and economics. The final contribution was the insight gained from a study of various approaches in preparing students for off-farm agricultural occupations.

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APPENDICES

APPENDIX A

Test on General Information

Work Opinion Inventory

Off-Farm Agriculture Occupation Opinion Inventory

Job Questionnaire

Follow-up Study

Job Description

Test on Principles of Plant and Animal Science

Test on Principles of Mechanics

Test on Agricultural Management and Marketing Principles

Agricultural Achievement Test, Part I

Agricultural Achievement Test, Part II

Agricultural Achievement Test, Part III

Agricultural Achievement Test, Part IV

Biographical Information

Attitude Scale

Student Information

The following schedule outlines approximate dates on which each of the test instruments was administered:

School year 1965-1966

Tenth grade (Principles Phase)
- September
  - Test on Plant and Animal Science Principles
  - Work Opinion Inventory
  - Off-Farm Agricultural Occupations Inventory
- May
  - Test on Plant and Animal Science Principles
  - Work Opinion Inventory
  - Off-Farm Agricultural Occupations Inventory

Twelfth grade (Off-Farm Agricultural Occupations Phase)
- September
  - Test on General Information for Prospective Workers
  - Work Opinion Inventory
  - Off-Farm Agricultural Occupations Opinion Inventory
- January
  - California Test of Mental Maturity--Short Form
  - Personal and Family Information
  - Attitude Scale
  - Strong Vocational Interest Blank
  - Bennett Test of Mechanical Comprehension
- May
  - Test on General Information for Prospective Workers
  - Work Opinion Inventory
  - Off-Farm Agricultural Occupations Opinion Inventory
  - Agricultural Achievement Test

School year 1966-1967

Eleventh grade (Principles Phase)
- September
  - Test on Principles of Mechanics
  - Work Opinion Inventory
  - Off-Farm Agricultural Occupations Opinion Inventory
- May
  - Test on Principles of Mechanics
  - Work Opinion Inventory
  - Off-Farm Agricultural Occupations Opinion Inventory

- Twelfth grade (Off-Farm Agricultural Occupations Phase)
  - September
    - Test on General Information for Prospective Workers
    - Work Opinion Inventory
    - Off-Farm Agricultural Occupations Opinion Inventory
  - January
    - California Test of Mental Maturity--Short Form
    - Personal and Family Information
    - Attitude Scale
    - Strong Vocational Interest Blank
    - Bennett Test of Mechanical Comprehension
  - May
    - Test on General Information for Prospective Workers
    - Work Opinion Inventory
    - Off-Farm Agricultural Occupations Opinion Inventory
    - Agricultural Achievement Test

School year 1967-1968

- Twelfth grade (OFAO) and (Principles)
  - All the same as twelfth grade in 1965-1966
  - Principles students also took:
    - Test on Agricultural Marketing and Management Principles, (Pre and Post)

  Principles students did not take Test on General Information for Prospective Workers

APPENDIX B

Principles in Animal, Plant, Soil Science

Principles in Agricultural Mechanics

Principles in Agricultural Marketing and Management

APPENDIX C

Agricultural Supply, Sales, and Service Occupations

Part I--General Information

Part II--Feed Sales and Service Occupations

Part III--Fertilizer Sales and Service Occupations

Part IV--Crop, Lawn and Garden Seed Sales and Service Occupations

Part V--Petroleum and Petroleum Products Sales and Service Occupations

A Syllabus for General Related Instruction for Off-Farm Agricultural and Diversified Occupations in Nebraska

Tractor Repair and Maintenance Course of Study

ED055773

APPENDIX A

Test on General Information
Work Opinion Inventory
Off-Farm Agriculture Occupation Opinion Inventory
Job Questionnaire
Follow-up Study
Job Description
Test on Principles of Plant and Animal Science
Test on Principles of Mechanics
Test on Agricultural Management and Marketing Principles
Agricultural Achievement Test, Part I
Agricultural Achievement Test, Part II
Agricultural Achievement Test, Part III
Agricultural Achievement Test, Part IV
Biographical Information
Attitude Scale
Student Information

VT010311

Test on General Information

for Prospective Workers

Thomas J. Lyons and Carl Rcdery
University of Nebraska, Lincoln, Nebraska

1. The Diversified Occupational Program is limited to students who:

   A. Plan to go to college
   B. Need to work
   C. Plan on full-time employment after graduation
   D. None of these

2. The idea of on-the-job training started:

   A. In England
   B. With the first unions
   C. In Mississippi in 1933
   D. With a father teaching his son a trade

3. The classes associated with your job are called:

   A. General
   B. Related
   C. On-the-job training
   D. Required

4. Which of the following is not a responsibility of the coordinator?

   A. Secure employment for the student
   B. Counsel with the student about his problems
   C. Help plan classroom learning
   D. Confer with the student's employer about job progress

5. Who is specifically concerned with the organization and administering of the Diversified Occupational Program?

   A. Employer
   B. Principal
   C. Coordinator
   D. Guidance couselor

6. Part-time Occupational Programs are important because they offer the student:

   A. On-the-job training
   B. Modern equipment to work with
   C. Wages and benefits
   D. A chance to adjust to a working situation

7. What should be the most important consideration before you accept a job?

   A. Chances for advacement within the company
   B. Working conditions
   C. Beginning wages
   D. Experience and training possibilities

200
LH

Work Opinion Inventory

Thomas J. Lyons Research Associate Educational Psychology and Measurements
University of Nebraska Lincoln, Nebraska

Directions:
(1) Write your name on this paper.
(2) The following is a list of statements about Work.
(3) Read each item carefully and circle one of the five choices which best describes your feelings about the statement. The five choices are:

SA	strongly agree
A	agree
N	no feeling
D	disagree
SD	strongly disagree

SA A N D SD 1. People who find little satisfaction in their work are missing out on one of the most important things in life.

SA A N D SD 2. A person who works hard will get ahead in this world.

SA A N D SD 3. It is wrong not to work.

SA A N D SD 4. People who work hard all their life are foolish.

SA A N D SD 5. Most people would be happier if they didn't have to work.

SA A N D SD 6. Work is a source of frustration and boredom.

SA A N D SD 7. If people didn't work their lives would be miserable.

SA A N D SD 8. Work is a necessary and useful part of everyone's life.

SA A N D SD 9. Most of our hopes and dreams can be realized through hard work.

SA A N D SD 10. Young people who appreciate the value of work develop into mature and responsible adults.

SA A N D SD 11. Working is one of the best ways to develop a person's character

SA A N D SD 12. People in this country would be better off if they relaxed more and worked less.

SA A N D SD 13. Most people find that the more they work the less they like it.

SA A N D SD 14. People put too much emphasis on work.

SA A N D SD 15. A really successful person does not have to work very hard for what he gets.

SA A N D SD 16. Some of our most pleasant assciations will be with the people with whom we work.

SA A N D SD 17. One of the best ways to know a person is to work with him.

Off-Farm Agricultural Occupations Opinion Inventory

Thomas J. Lyons Research Associate Education Psychology and Measurements
University of Nebraska Lincoln, Nebraska

Off-farm agricultural occupations are occupations in which agricultural knowledge and skills are needed for successful work in the occupation. Knowledge and skill areas include plant science, animal science, soil science, agricultural business management and marketing, and agricultural mechanics. There is a great variety of these occupations ranging from farm implement repairman to fertilizer applicator to manager of a farm loan service.

Directions:

(1) Write your name on this paper.
(2) The following is a list of statements about off-farm agricultural occupations.
(3) Read each item carefully and circle one of the five choices which best describes your feelings about the statement. The five choices are:

SA	strongly agree
A	agree
N	no feeling
D	desagree
SD	strongly disagree

SA A N D SD 1. There is no real future in off-farm agricultural occupations.

SA A N D SD 2. I can do a lot of good for society by entering an off-farm agricultural occupation.

SA A N D SD 3. An off-farm agricultural occupation will provide me with a very good income.

SA A N D SD 4. Off-farm agricultural occpations offer routine and tiresome work.

SA A N D SD 5. A great deal of variety is offered in off-farm agricultural occupations.

SA A N D SD 6. People working in off-farm agricultural occupations are well respected members of the community.

SA A N D SD 7. People in off-farm agricultural occupations add little to the community in which they live.

SA A N D SD 8. Off-farm agricultural occupations will allow me to work with a variety of interesting people.

SA A N D SD 9. There is limited opportunity for advancement in off-farm agricultural occupations.

SA A N D SD 10. I would not like the working conditions in an off-farm agricultural occupation.

____
(Name)

Job Questionaire*

Directions:
(1) Write your name on this paper.
(2) The following is a list of statements about jobs.
(3) Read each item carefully and circle one of the five choices which best describes your feelings about the statement. The five choices are:

SA	strongly agree
A	agree
N	no feeling
D	disagree
SD	strongly disagree

SA A N D SD 1. My job is like a hobby to me.

SA A N D SD 2. My job is usually interesting enough to keep me from getting bored.

SA A N D SD 3. It seems that my friends are more interested in their jobs.

SA A N D SD 4. I consider my job rather unpleasant.

SA A N D SD 5. I enjoy my work more than my leisure time.

SA A N D SD 6. I am often bored with my job.

SA A N D SD 7. I feel fairly well satisfied with my present job.

SA A N D SD 8. Most of the time I have to force myself to go to work.

SA A N D SD 9. I am satisfied with my job for the time being.

SA A N D SD 10. I feel that my job is no more interesting than others I could get.

SA A N D SD 11. I definitely dislike my work.

SA A N D SD 12. I feel that I am happier in my work than most other people.

SA A N D SD 13. Most days I am enthusiastic about my work.

SA A N D SD 14. Each day of work seems like it will never end.

SA A N D SD 15. I like my job better than the average worker does.

SA A N D SD 16. My job is pretty uninteresting.

SA A N D SD 17. I find real enjoyment in my work.

SA A N D SD 18. I am disappointed that I ever took this job.

*Adapted from a scale developed by Brafield and Rothe as reported in the *J. appl. Psychol.*, 1951, *35*, 307-311.

Follow-Up Study

Class of 1966-1967-1968

Nebraska Vocational Agricultural Education Project (001)

1. Name ______________ ______________ Date ______________
LAST FIRST Month Day Year

2. Address ______________________________

3. In the period of time beginning with June 1, 1968 and ending now, which of the following activities have you been involved in? (Check ALL that apply)

a. I have worked on a job. . . . .( )
b. I have been in the military service . . . .( )
c. I have been enrolled in a trade or business school. .( )
d. I have been enrolled at a college or university . . .( )
e. I have been unemployed (over 1 month) . . . .( )
f. Other ______________________ (Specify) . . . .( )

> IF YOU CHECKED THAT YOU WORKED ON A JOB DURING THE PAST YEAR, COMPLETE QUESTIONS 4 AND 5. IF YOU DID NOT WORK DURING THIS TIME, YOU DO NOT NEED TO FILL OUT ANY MORE OF THE QUESTIONS.

4. Below list all jobs you have held from June 1, 1968, to the present time.

1
Job Description ______________________________
Employer ______________ (Name of Company) ______________ (Address of Company)
Date Started ______________ Date Finished ______________
Salary per week $ ______________ Hours worked per week ______

2
Job Description ______________________________
Employer ______________ (Name of Company) ______________ (Address of Company)
Date Started ______________ Date Finished ______________
Salary per week $ ______________ Hours worked per week ______

3
Job Description ______________________________
Employer ______________ (Name of Company) ______________ (Address of Company)
Date Started ______________ Date Finished ______________
Salary per week $ ______________ Hours worked per week ______

5. The following is a list of statements about jobs. Think about the last job you held (if you are not presently working) or your present job (if you are now working) and read the statements carefully. For each statement circle one of the five choices which describes your feelings about your job. The five choices are:

SA	Strongly Agree
A	Agree
N	No Feeling
D	Disagree
SD	Strongly Disagree

SA A N D SD 1. My job is like a hobby to me.

SA A N D SD 2. My job is usually interesting enough to keep me from getting bored.

SA A N D SD 3. It seems that my friends are more interested in their jobs.

SA A N D SD 4. I consider my job rather unpleasant.

SA A N D SD 5. I enjoy my work more than my leisure time.

SA A N D SD 6. I am often bored with my job.

SA A N D SD 7. I feel fairly well satisfied with my present job.

SA A N D SD 8. Most of the time I have to force myself to go to work.

SA A N D SD 9. I am satisfied with my job for the time being.

SA A N D SD 10. I feel that my job is no more interesting than others I could get.

SA A N D SD 11. I definitely dislike my work.

SA A N D SD 12. I feel that I am happier in my work than most other people.

SA A N D SD 13. Most days I am enthusiastic about my work.

SA A N D SD 14. Each day of work seems like it will never end.

SA A N D SD 15. I like my job better than the average worker does.

SA A N D SD 16. My job is pretty uninteresting.

SA A N D SD 17. I find real enjoyment in my work.

SA A N D SD 18. I am disappointed that I ever took this job.

If you have any comments about your job or otherwise, please write them below. Thanks for your help! ______________________________

____

(Students name)

Date	Job Description	Dates Employed		Salary	Hours Worke
		start	finish	per week	per we
6/66					
7/66	(2 month follow-up)				
8/66					
9/66					
10/66					
11/66					
12/66					
1/67					
2/67					
3/67					
4/67					
5/67					
6/67					
7/67	(1 year follow-up)				
8/67					
9/67					
10/67					
11/67					
12/67					
1/68					
2/68					
3/68					
4/68					
5/68					
6/68					
7/68	(2 year follow-up)				

Test on the Principles of

Plant and Animal Science

Thomas J. Lyons and Roland Peterson
University of Nebraska, Lincoln, Nebraska

1. The blood carries on numberous activities in a living organism. Which of the following answers is not a characteristic of blood?

   A. Has no cellular structure
   B. Removal of metabolic wastes
   C. Carries oxygen and water to cells
   D. Transports digested food and body secretions
   E. Contains components which defend the body against infection

2. In order to survive, living things possess the ability to perpetuate their own kind from a part of themselves. All but one of the following terms are related to this statement:

   A. Asexual reproduction
   B. Sexual reproduction
   C. Cross pollination
   D. Crop rotation
   E. Meiosis

3. All things, living and non-living, are either matter or energy. Which of the following does not apply to matter or energy?

   A. The sun is the ultimate source of energy for most organisms
   B. Matter is composed of small units called atoms
   C. Matter cannot be transformed into energy
   D. Electricity, heat, and light are forms of energy
   E. Energy may be measured in units called calories

4. On the basis of the genes they possess, which of the following cattle would be most closely related?

   A. Sire and daughter
   B. Identical twin calves
   C. Dam and daughter
   D. Dam and sire
   E. Sire and son

5. When two different breeds of purebred animals are crossed or mated to each other, the resulting offspring is:

   A. Usually deformed and inferior to the purebred parents
   B. Usually superior and more vigorous than either purebred parent
   C. Completely unlike either parent in phenotype and genotype
   D. Genrally sterile
   E. A combination of dominant genes and recessive genes which have little effect on the offspring

Test on
PRINCIPLES OF MECHANICS

Thomas J. Lyons and Roland Peterson
University of Nebraska
Lincoln, Nebraska

1. Heat can do mechanical work by passing from a region of:

   a. high energy to one of low energy
   b. low temperature to one of high temperature
   c. low energy to one of high energy
   d. large area to one of small area
   e. high temperature to one of low temperature

2. Which of the following statements is correct for both 2 stroke cycle and 4 stroke cycle engines?

   a. valve placement is the same
   b. revolutions per cycle are the same
   c. compression and power strokes are the same
   d. exhaust and intake strokes are the same
   e. compression and intake strokes are the same

3. During the compression stroke of an engine the temperature rises because:

   a. the spark plug provides heat
   b. the fuel-air mixture is ignited
   c. of the increased friction of the pistons
   d. pressure is increased in the cylinder
   e. hot gases are being moved out of the cylinder

4. In an internal combustion engine the relationship between the volume of gas in the cylinder at the bottom of the intake stroke to the volume of gas in the cylinder at the top of the compression stroke is referred to as:

   a. the bore-stroke relationship
   b. the piston displacement
   c. the compression ratio
   d. the stroke of the piston
   e. the temperature gradient

5. Pre-ignition or knocking in a gasoline engine is caused by:

   a. impurities in the fuel
   b. too low an octane rating
   c. oil fouled spark plugs
   d. too low a cetane rating
   e. too high an octane rating

TEST ON
AGRICULTURAL MANAGEMENT AND MARKETING PRINCIPLES

Leo Harvill, Roland Peterson and Darrell Siekman
University of Nebraska
Lincoln, Nebraska

1. A fixed cost refers to an item such as:
   a. depreciation.
   b. fuel.
   c. seed.
   d. labor.
   e. fertilizer.

2. The prices a farmer pays for machinery, supplies and materials remain more stable than the products he sells. Thus, the farmer's purchasing power fluctuates a great deal. This has resulted in the establishment of a base price referred to as:
   a. futures.
   b. parity.
   c. net income.
   d. cost price squeeze.
   e. vertical integration.

3. After obtaining a farm, either by purchase or rental, a farmer should give primary consideration to:
   a. purchasing additional equipment.
   b. obtaining a source of credit for operating expenses.
   c. purchasing livestock for the utilization of hayland.
   d. determining fertilizer needs of the farm.
   e. making an inventory of the farm situation.

4. One of the primary advantages of specialization in farming is:
   a. the full use of technological developments in producing an item at low costs.
   b. the greater use of labor.
   c. the most effective use of farm machinery
   d. the most effective use of land resources.
   e. the new development in storage equipment allowing the farmer to take advantage of high prices.

5. The price established for a farm commodity is basically determined by:
   a. government price support programs.
   b. the food situation in foreign countries.
   c. the supply and demand for the product.
   d. the desires of consumers in a particular community.
   e. the costs of producing the product.

AGRICULTURAL ACHIEVEMENT TEST

Part I: Plant and Soil Science

Prepared by

Thomas J. Lyons, C. Edward Henderson, Alan A. Kahler,
Robert C. Mason, M. Garfield McCreight, and Roland L. Peterson

The Nebraska Agricultural Education Project
Department of Agricultural Education

University of Nebraska Agricultural Experiment Station
H. H. Kramer, Director E. F. Frolik, Dean
Lincoln, Nebraska, 1966

1. A perennial plant:
   a. is a short-lived plant.
   b. has a life cycle that takes place within one growing season.
   c. does not normally bloom until the second season after the seed is grown.
   d. lives from year to year with varying blooming periods.
   e. requires two growing seasons to complete the life cycle.

2. The process by which legume bacteria converts free gaseous nitrogen from the air into available nitrogen is known as:
   a. ammonification.
   b. symbiosis.
   c. nitrogen fixation.
   d. nitrification.
   e. inoculation.

3. Food manufacture is a primary function of the:
   a. root.
   b. leaf.
   c. stem.
   d. nutrients in the soil.
   e. seed.

4. The growth of a new plant from the seed is called:
   a. fertilization.
   b. reproduction.
   c. germination.
   d. pollination.
   e. self-pollination.

5. A rhizome is a(n):
   a. underground stem.
   b. leaf.
   c. root hair.
   d. root.
   e. bacteria.

6. The process of oxidation is most closely associated with:
   a. photosynthesis.
   b. digestion.
   c. fertilization.
   d. transpiration.
   e. respiration.

7. The pasturing of wheat:
   a. may cause an excessive amount of lodging before harvest time.
   b. will usually increase the wheat yields.
   c. may cause trampling damage to the wheat if the soil is wet.
   d. should be limited to the stubble after harvest.
   e. is limited to the spring varieties.

8. The main advantage of grain sorghum over corn is its:
   a. increased feed value.
   b. better standability.
   c. need for less nutrients.
   d. ability to survive when planted earlier than corn.
   e. drought resistant qualities.

AGRICULTURAL ACHIEVEMENT TEST

Part II: Mechanics

Prepared by

Thomas J. Lyons, C. Edward Henderson, Alan A. Kahler,
Robert C. Mason, M. Garfield McCreight, and Roland L. Peterson

The Nebraska Agricultural Education Project
Department of Agricultural Education

University of Nebraska Agricultural Experiment Station
H. H. Kramer, Director E. F. Frolik, Dean
Lincoln, Nebraska, 1966

1. After all regulator, hose and torch connections on an oxyacetylene welding outfit have been correctly made the first step in preparation for lighting the torch is to close the regulator valves on both the oxygen and acetylene tanks. The next step is to:
   a. light the torch.
   b. open the regulator valves.
   c. open the oxygen and acetylene cylinders valves.
   d. test for leaks.
   e. tighten the valve packing nut on the acetylene cylinder.

2. Which one of the following kinds of flames is used for welding cast iron with the oxyacetylene torch?
   a. Oxidizing flame
   b. Neutral flame
   c. 2x flame
   d. 3x flame
   e. 2½x flame

3. The method of joining two pieces of iron with an arc welder is known as:
   a. soldering
   b. brazing
   c. metalizing
   d. fusing
   e. bronzing

4. Which one of the following lots of lumber contain exactly 16 board feet?
   a. 1 piece 1" x 16" x 1'
   b. 3 pieces 4" x 4" x 8'
   c. 12 pieces 1" x 12" x 16'
   d. 6 pieces 2" x 2" x 4'
   e. 1 piece 2" x 8" x 12'

5. Indicate which of the following circular saw blades is hollow ground.
   a. Cross cut
   b. Planer
   c. Rip
   d. General purpose
   e. Plywood

6. Of the five kinds of hand planes used in carpentry the block plane should be used in:
   a. preparing a joint for gluing.
   b. smoothing against the grain of the wood.
   c. smoothing a concave surface.
   d. smoothing the face of a board.
   e. smoothing the end of a board.

7. The first step in hand threading an iron bolt is to file or grind off any projections on the end to be threaded, slightly tapering it. The next step is to:
   a. select the proper size tap.
   b. place the tap squarely on the bolt and apply pressure evenly on the tap as it is turned to get the threads started.
   c. select the proper size die.
   d. turn the die back and forth slightly while cutting threads to allow the metal chips to fall out.
   e. apply cutting oil.

AGRICULTURAL ACHIEVEMENT TEST

Part III: Animal Science

Prepared by

Thomas J. Lyons, C. Edward Henderson, Alan A. Kahler,
Robert C. Mason, M. Garfield McCreight, and Roland L. Peterson

The Nebraska Agricultural Education Project
Department of Agricultural Education

University of Nebraska Agricultural Experiment Station
H. H. Kramer, Director E. F. Frolik, Dean
Lincoln, Nebraska, 1966

1. A pedigree of any animal is essentially:
   a. a record of performance.
   b. a record of its ancestry.
   c. a record of potency.
   d. a record of show ring winnings
   e. a record of production.

2. The gestation period is:
   a. the length of time the mother is giving milk.
   b. the time at which conception occurs.
   c. the time from conception until the offspring is born.
   d. the period when the female will receive the male and the act of mating occurs.
   e. the time when the mother goes into labor until the offspring is born.

3. The largest stomach compartments in cattle is the:
   a. caecum.
   b. rumen.
   c. omasum.
   d. abomasum.
   e. reticulum.

4. A sudden variation which is later passed on through inheritance and results from changes in a gene or genes is called:
   a. impurity.
   b. mutation.
   c. chromosome linkage.
   d. dwarfism.
   e. heterzygosity.

5. In artificial insemination the primary reason for freezing sperm is to:
   a. synchronize mating with ovulation.
   b. slow metabolism which maintains fertility.
   c. increase the number of females that might be inseminated.
   d. insure conception.
   e. make handling easier.

6. A livestock producer may expand the merits of a top quality sire and prevent spreading of certain reproductive diseases by:
   a. careful selection.
   b. purchasing only proven sires.
   c. artificial insemination.
   d. using only Scientific Pathogen Free (SPF) animals.
   e. purchasing only from reputable breeders.

7. In animal breeding the simplest unit of inheritance is called a:
   a. chromosome.
   b. sperm.
   c. ovum.
   d. zygote.
   e. gene.

AGRICULTURAL ACHIEVEMENT TEST

Part IV: Management

Prepared by

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The Nebraska Agricultural Education Project
Department of Agricultural Education

University of Nebraska Agricultural Experiment Station
H. H. Kramer, Director E. F. Frolik, Dean
Lincoln, Nebraska, 1966

1. The price of a product or an item is determined by:
   a. the level of production costs.
   b. the profit margin established by the retailer.
   c. the material needs of the consumers.
   d. the supply of products and the demand for the product.
   e. the size of business and volume of sales.

2. What marketing agency receives a percentage of the gross receipts for preparing and selling a product for the producer?
   a. Commission firm.
   b. Wholesaler.
   c. Brokerage firm.
   d. Jobber.
   e. Buyer.

3. A major reason for the seasonal variation in hog prices is:
   a. government support prices are higher some months than others.
   b. that during some seasons large quantities of pork are shipped overseas.
   c. the number of hogs marketed per month varies more than the amount of pork desired by consumers at a given price.
   d. that there has been a decrease in the per capita consumption of pork over the past 20 years.
   e. that there are fewer hogs in the country today.

4. The reason cattle grading high choice to prime receive a high price is due to the fact that:
   a. the higher grades of cattle are fed a better ration, hence the meat is more nutritious.
   b. the higher grades of cattle have less waste.
   c. the higher grades of cattle produce carcasses which shrink less.
   d. the supply of higher grades of cattle is extremely limited.
   e. the higher grades of cattle yield more valuable retail cuts.

5. The Packers and Stockyards Act was enacted as a marketing regulation to:
   a. prevent farmers from selling animals with large amounts of fill.
   b. prevent packers from engaging in unfair practices which would affect market prices.
   c. prevent packers from raising livestock in their own feedlots.
   d. prevent farmers from picketing the livestock market.
   e. protect the packers from unfair practices of transportation companies.

6. What effect has the government price support program had on the grain market?
   a. Has caused prices to gradually decline.
   b. Has tended to hold prices down.
   c. Has resulted in an increase in "futures" trading.
   d. Has been an effective control on production.
   e. Has had a stabilizing effect on the prices.

7. A marketing service which influences prices by controlling supply is:
   a. processing.
   b. grading.
   c. transportation.
   d. assembling.
   e. storage.

Biographical Information

____
(Name)

1. I live:
( ) on a farm or ranch
( ) in the open country but not on a farm or ranch
( ) in a village or town

2. The occupation I plan to follow after I complete my education is:
(if uncertain, indicate the job you think you will follow) ______________

______________ (Describe the type of work you plan to do)

____

____

3. The amount of education I plan to get is:
( ) less than a high school diploma
( ) high school diploma
( ) trade or business school
( ) junior college or some college
( ) bachelor's degree from a university or 4 year college
( ) master's degree
( ) degree necessary to be a doctor, lawyer, dentist or veterinarian
( ) Ph.D. or Ed.D.
( ) other (specify) ______________________________

4. If I were absolutely free to go into any kind of work I wanted, my choice would be ______________________
(Describe the type of work you would do)

____

____

5. If I were completely free (conditions such as family approval, enough money, and adequate ability) to get as much education as I wanted, I would want:
( ) less than a high school diploma
( ) high school diploma
( ) trade or business school
( ) junior college or some college
( ) bachelor's degree from a university or 4 year college
( ) master's degree
( ) degree necessary to be a doctor, dentist, lawyer, or veterinarian
( ) Ph.D. or Ed.D.
( ) other (specify) ______________________________

6. My father's (guardian's) occupation is (or was, if dead or retired):

____
(Describe the kind of work he does or did) ______________________________

____

____

7. If my father is a farmer or rancher he is primarily engaged in:
(   ) farming
(   ) ranching

8. How many acres does my father
own ______________
rent ______________ (rent from someone)
operate ______________

9. My father's education consists of:
(   ) less than 8 grades
(   ) 8 grades
(   ) 9-11 grades
(   ) 12 grades (high school diploma)
(   ) trade or business school
(   ) junior college or some college
(   ) bachelor's degree from a university or 4 year college
(   ) graduate or professional work beyond the bachelor's degree

10. My mother's education consists of:
(   ) less than 8 grades
(   ) 8 grades
(   ) 9-11 grades
(   ) 12 grades (high school diploma)
(   ) trade or business school
(   ) junior college or some college
(   ) bachelor's degree from university or 4 year college

____
Identification

ATTITUDE SCALE

This scale has been prepared so that you can indicate how you feel about this class. PLEASE RESPOND TO EVERY ITEM. In each case, draw a circle around the letter which represents your own reaction as follows:

SA	if you strongly agree with the statement
A	if you agree but not strongly so
N	if you are neutral or undecided
D	if you disagree but not strongly so
SD	if you strongly disagree with the statement

Remember, the only correct answer is the one which actually represents how you feel about this class.

1. My attitude about the methods used in teaching this course can be described as "satisfactory"............ SA A N D SD
2. Increasing the contact between teacher and students would improve this class.............................. SA A N D SD
3. I like the way this class is taught.................. SA A N D SD
4. The unimportant topics in this class have been given too much time.................................... SA A N D SD
5. I cannot see any advantage for this method of teaching over any other methods.................... SA A N D SD
6. My highest expectations have been exceeded in this class.. SA A N D SD
7. The method of teaching this class works well for some students but not for others......................... SA A N D SD
8. The rate of presenting material in this class is too fast.. SA A N D SD
9. I am happy that the method of teaching this class was used.. SA A N D SD
10. My feeling about this class is one of disappointment.. SA A N D SD
11. This class gives me real enthusiasm for the study of this subject....................................... SA A N D SD
12. I already know the material in this class yet the method of instruction forces me to spend time on it... SA A N D SD
13. All other classes should be taught by the same method used in this class................................ SA A N D SD
14. There is not as much student participation in this class as there should be........................... SA A N D SD
15. The progress of the class is delayed because of the teaching method used............................ SA A N D SD
16. Because of the method used in this class the material stays with me...................................... SA A N D SD
17. I have learned more in this class than I expected to learn.. SA A N D SD
18. As far as freedom is concerned, the method of instruction in this class doesn't give me enough...... SA A N D SD
19. The teaching method in this class gives me a feeling of enthusiasm..................................... SA A N D SD
20. The method of instruction used in this class needs a lot of improvement............................... SA A N D SD
21. There is good organization of subject matter in this class.. SA A N D SD
22. This class is not as good as I had hoped it would be.. SA A N D SD
23. In this class I have not had a chance to go back over the material...................................... SA A N D SD
24. I am interested in the content of this class......... SA A N D SD

Student Information

____
(Name)

No. of Graduates ____________ Rank in class ______________________
(1st highest)

Subject Area	Course Description		Check those semesters for which credit was received							
		Grade	9		10		11		12	
		Year	19		19		19		19	
		Semester	1	2	1	2	1	2	1	2
English										
Language										
Math										
Science										
Soc. Science										
Commercial										
Voc. Ag.										
Voc., other										
General										

_____________________ _____________________
(Name) (High School)

Name and address of the institution where you received your Bachelor's Degree ______________________________

____

Number of credit hours completed beyond your Bachelor's Degree ________

If you have a Master's Degree, indicate the name and address of the institution where you received it ______________________________

____

Number of credit hours completed beyond your Master's Degree ________

How many years have you been teaching Vocational Agriculture in high school? ______________________________

ED035773

APPENDIX B

Principles in Animal, Plant, Soil Science

Principles in Agricultural Mechanics

Principles in Agricultural Marketing and Management

VT010311

ED035773

UNIVERSITY
OF
NEBRASKA

PRINCIPLES
IN
ANIMAL SCIENCE
PLANT SCIENCE
SOIL SCIENCE

app ø ВСІ

James T. Horner
and
Roland L. Peterson

Publication No. 1 - 1965

VT010311

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

This publication was prepared in furtherance of a project supported by a grant from the U. S. Department of Health, Education, and Welfare, Office of Education, entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming." The project was initiated by the Department of Agricultural Education of the University of Nebraska, and has been designated DAVR Project No. 001-65, and Contract No. OE-05-85-020.

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FOREWORD

This Handbook has been prepared expressly for use in a study entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming", which is being conducted by the Department of Agricultural Education, Agricultural Experiment Station, College of Agriculture and Home Economics, University of Nebraska in cooperation with the State Board for Vocational Education, State of Nebraska. One part of the study deals with curriculum organization of vocational agriculture instruction. Specifically, it is desired to compare instruction based on the principles underlying agriculture with instruction based on the activities of agricultural workers. The immediate point of interest is to determine which plan of instructional organization is most effective in preparing high school students for entry into off-farm agricultural occupations.

In light of the extensive pioneering work which was conducted in California, at the University of California at Davis, financed by a grant from the National Defense Education Act, it seemed appropriate that the instruction organized around the principles of agriculture be based on the publication *Biological Principles in Agriculture* which was prepared by Sidney S. Sutherland, Professor of Agricultural Education, University of California, Davis, and W. Earl Sams, Consultant, Bureau of Secondary Education, California State Department of Education, and published by the California State Department of Education. Professor Sutherland served as consultant to the Nebraska project, and indicated a number of suggestions and additions which have been incorporated into this Handbook. The Handbook, therefore, is an example of an adaptation of the California materials for use in another state, and those of us associated with the Nebraska project desire to express our deepest appreciation and gratitude not only for the California materials,*per se*, but also for the permission to adapt these materials for use in Nebraska schools.

In addition to expressing appreciation to Messrs. Sutherland and Sams for the basic framework of this publication, it is appropriate that recognition be given to Dr. John K. Coster, North Carolina State University, who served as project director when the original publication entitled "Life Science Principles Applied In Agriculture" was developed. Acknowledgement is due the Nebraska teachers of Vocational Agriculture who suggested the changes appearing in this publication, namely:

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PREFACE

Agriculture is largely applied biology, the science of living organisms. The plant and animal sciences must be considered important agricultural sciences. Therefore, the plant and animal sciences and a portion of soil formation which aids in the support of life are included in this teaching guide.

It has long been accepted that "principles should be taught with applications"; that teaching is most effective when these two important kinds of content are presented in the closest possible relationship with each other.

The "principle" approach lends itself to instruction for understandings, essential to the ability to make appropriate applications.

This guide is an aid in helping teachers relate daily occurrences in agriculture to biological science principles which govern common day-to-day experiences. Thus, the decision was made to develop teaching materials around biological science principles and their application to agriculture.

Each teaching unit herein is based on a biological (animal and plant) or soil science principle that has important applications to agriculture. Omitted, because they have limited importance to agriculture, are the areas of human physiology, flowerless plants, and invertebrate zoology, usually studied in a typical high-school biology course.

TERMINOLOGY

The question may be asked, "What is a principle and how do principles differ from a concept, a rule or a fact?" According to Sutherland and Sams,

> "A Principle is a fundamental truth, a law of conduct, that has general applications and is a basis for action. It is a generalization based on facts and on elements of "likeness" common to a number of situations. Since a principle is a generalization, there are sometimes minor exceptions to it, but it still has general application."[1]

The following statements are a comparison of a principle with a rule, a fact, a concept, or a law.

A rule is a specific direction or regulation for action, and is generally based upon a principle or principles.

A fact simply states something that actually exists or has been done.

A concept is a generalization made by an individual. It is an idea, a mental image based upon an understanding of all that is associated with or suggested by a term.

A law is a generalization that, so far as it is known, is invariable under given conditions.[2]

---

[1] Sidney S. Sutherland and W. Earl Sams, Biological Principles in Agriculture, California State Department of Education and University of California, Davis, California, 1963, p.2.

[2] Ibid., pp. 2-3.

BASIC ANIMAL, PLANT, AND SOIL SCIENCE PRINCIPLES

1. Matter and Energy

   All things, living and non-living, are either matter or energy, or a combination of matter and energy.

2. Living vs. Non-Living Matter

   All living things are composed of protoplasm and carry on the life processes of reproduction, nutrition, and irritability or respond to stimuli.

3. Soil Formation

   In general, parent material for the development of soils is formed through the physical disintegration and chemical decomposition of rock particles.

4. Diffusion and Osmosis

   Life depends on the fact that materials tend, in general, to move from an area of low concentration.

5. Genetics

   All organisms resemble and differ from their parents to a degree that depends on the interaction and/or segregation of genes, environmental factors, and the occurrence of mutations.

6. Reproduction

   Living things are able to reproduce their own kind from a part of themselves.

7. Growth

   Growth takes place over extended periods only when the rate of synthesis of protoplasm exceeds the rate of protoplasmic degradation.

8. Movement of Substances in Living Organisms

   All organisms depend to various degrees on a system by which nutrients, oxygen, and regulatory secretions are distributed in the organisms, and the waste products of metabolism are removed. In higher organisms this same system is also used in regulating body temperature and preventing and controlling disease.

9. Classification

   Living organisms are classified on the basis of similarity of structure and function.

   The greater the similarity of any two organisms the closer the relationship.

10. Photosynthesis

Life on earth, both plant and animal, depends on photosynthesis, the process by which plants use energy from the sun in manufacturing food.

11. Transpiration

All plants transpire. Whenever the uptake of water by the roots is slower than the rate of transpiration, wilting will occur. The severity of damage, if any, will depend on the kind of plant, the state of growth and the duration of the condition.

12. Plant Nutrition and Organic Cycles

A plant's ability to attain maximum growth, development, and maintenance is directly related to the availability of all the essential nutrients, provided other environmental factors are favorable.

All plant and animal life is dependent upon cycles in which quantities of certain essential elements are kept in constant circulation among plants, animals, soil, air, and water, and are used over and over.

13. Regulators of Plant Growth and Development

All living things require specialized chemical substances to regulate the life processes necessary for growth and development.

14. Germination of Seeds

Viable seeds germinate when conditions of dormancy are satisfied and environmental conditions are favorable.

15. Animal Nutrition and Digestion

The benefit an organism derives from its food is dependent upon the composition and nutritive value of the food, and the ability of the organism to utilize this.

16. Skeletal and Muscular Systems

Most animals require a skeleton of bones to support, shape and protect the animal's body. Motion is an important activity of the body and is brought about by the contraction of connection or muscles.

17. Animals Nervous System

In higher animals the activities of the various body parts are coordinated with each other and are capable of responding to changes in the environment, sometimes with the benefit of being able to profit from previous experience.

18. Farm Animals Integument

An animal is aeparated from its environment by a living envelope which covers the body and buffers the living protoplasm from drying, injury, infectious organisms and aids in body temperature regulation.

19. Respiration

All organisms derive the energy required for activities from the oxidation of simple foods within their protoplasm. The rate of energy release depends on internal and external factors that create the need for energy.

20. Excretion and Secretion

In organisms the end products of metabolism, water, carbon dioxide, and nitrogenous compounds are either stored in the cells as insoluble crystals or are eliminated in solution by diffusion or osmosis (excretion). Certain cells of the body may also release substances for the benefit of the organism (secretion).

21. Endocrine System

All vertebrate animals have endocrine glands that secrete special chemical substances capable of regulating the life processes of the organism.

22. Irritability and Tropisms

All living organisms have the ability to respond to stimuli in some fashion.

23. Pathology

All living organisms are subject to malfunctions from exterior or interior causes. If the malfunction is within the homeostatic limits of the organism, it survives in the diseased condition, or recovers. If the malfunction goes beyond these limits, death results.

(Sub-Principle:)

All living organisms have parasites capable of affecting their life processes to a degree that depends on the susceptibility of the host, the environment, and the nature of the parasite.

24. Ecology

In a changing environment, living organisms can survive only through adaptation and/or migration. Each species of living organisms has a range for each physical condition outside of which it cannot survive.

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INTRODUCTION

The material in this publication may be taught in a variety of methods. A method of teaching will be suggested to provide teachers with a guide in presenting this material.

The material presented in each principle unit is categorized as follows: (1) principle, (2) objectives, (3) application to agriculture, (4) demonstrations, experiments, problems, (5) definitions and facts, and (6) references. An inductive approach seems to be the most effective way of introducing the unit covered by the principle and/or principles. The key to inductive teaching is the withholding of any statement concerning the principle until the students have had an opportunity to observe, study and consider several instances which relate to the principle. The teacher should provide instances for discovery of the principle through the use of demonstrations, experiments and problems presented by the teacher, students or field observations. Before introducing each demonstration, experiment or problem the students should be asked, "What will happen?" and "Why does this occur?" The answer to these questions will eventually lead students to the discovery of the underlying principle. At this point, a deductive approach should be used to take the students from the known situation to its application to agriculture through the use of various problem solving and discussion techniques.

An example of the preceding procedure may be illustrated using the unit or principle area on "Diffusion and Osmosis". The suggested experiment may be "G" in which students may observe water movement through soil. A number of situations such as a layer of clay, a layer of sand, and a layer of gravel are intended to show how water moves from an area of high concentration to an area of low concentration depending upon a number of factors present in the soil. This is an observed effect and students should be asked why the water moves in a particular pattern. Eventually students will suggest or discover the phenomenon that water is moving from an area of high concentration to an area of low concentration. It is then an easy step for the teacher to reveal the principle of diffusion and osmosis which states "Life depends on the fact that materials tend, in general, to move from an area of high concentration to an area of low concentration". On the basis of this discovery, students may be directed to make agricultural applications. The factors involved in irrigation, methods of irrigation, irrigating procedures, problems of fertilizer placement, and problems of transplanting plants all become applications of the principle of diffusion.

Through this process, students have discovered the underlying principle inductively and have deductively applied the principle to real life situations. The student is made aware of the relationship between diffusion and osmosis and problems in irrigation and transplanting. The following outline is suggested as a guide or procedure for teaching vocational agriculture using the principles approach:

Problem: What procedure should we follow in teaching vocational agriculture using the principles approach?

Steps	Key Points
1. Introduce the principle by having students observe or experiment with known situations and/or problems.	a. Recall situations in production agriculture i regard to the principle. b. Teacher and/or students conduct experiments. c. Teacher conducts a demonstration. d. Teacher presents problems e. This is part IV of each unit outline. f. Withhold any statement concerning the principle.
2. Reveal the principle.	a. Draw conclusions from th students that each demonstration has something similar b. Have students write down their reasons why they feel a situation is occurring. c. Summarize the observation by stating the principle. d. Give students the definition of the principle.
3. Teach the facts and definitions regarding the principle.	a. The facts provide the students a background about the principle. b. Facts and definitions will aid in a further understanding of the principle. c. Facts and definitions should be mimeographed and presented as a handou to the students. d. A small or large group discussion technique may also be used in presenting the facts and definitions material.
4. Apply the principle to agriculture.	a. Teach the problems which relate to production and off-farm agriculture businesses.

	b. Provide shop, laboratory, classroom or field trip observation situations in presenting the knowledge and skill needed by students in relation to the principle. c. Use visuals or any type of learning resource media or material to effectively provide students with the agricultural knowledge and skill. d. The problem-solving method of teaching is an effective method of making the applications to agriculture.
6. Provide students with worksheets for review and individualized study.	a. After the applications have been completed allow students to complete the worksheets for each principle. b. Check the answers with the teacher's key.

MATTER AND ENERGY

I. PRINCIPLE:

All things, living and non-living, are either matter or energy, or a combination of matter and energy.

II. OBJECTIVES:

A. To develop an understanding of the association of matter and energy as a basis for agriculture.

III. APPLICATION TO AGRICULTURE:

Problems or Topics:
The following statements should be given to the student in a classroom discussion.

A. Matter and energy are associated with animal feeding and nutrition in that matter, in the form of feed materials hay, corn, soybean meal, etc., are fed to livestock producing energy in the animals' body for growth, heat, reproduction, maintenance and fattening.

B. Matter and energy are associated with agricultural production by affecting plant growth. The energy from the sun and matter in the form of soil nutrients result in the growth of plant cells. Nutrients may be added to a soil thus providing an increased amount of potential energy for increased plant growth and development.

C. Thus all things, living and non-living, are either matter or energy and are the basis for the production of crops and livestock.

D. Clay particles are positively charged ions and thus attract nutrients or elements that are negatively charged.

IV. DEMONSTRATIONS, EXPERIMENTS, PROBLEMS:

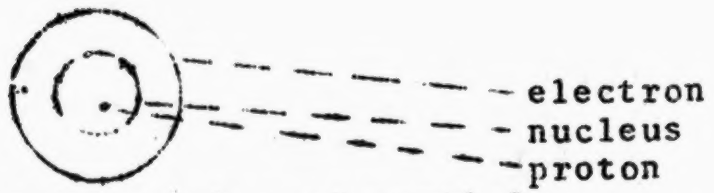
A. Grind a small piece of meat very finely and place it in a beaker partially filled with concentrated HCl. What happened? Why? (Matter changed to energy - This occurs when feed ingredients are fed to livestock.) In the process of change, heat is produced. Allow students to touch beaker to feel the heat produced as a result of energy released.

B. Ask students to describe change which occurs when a soil nutrient affects the growth of a living plant. What change takes place? Why?

V. DEFINITIONS AND FACTS:

A. Atom: a unit composed of the following fundamental particles; protons which bear a positive charge, electrons which bear a negative charge, and neutrons which bear no charge.

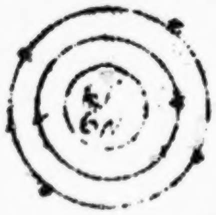
Hydrogen atom

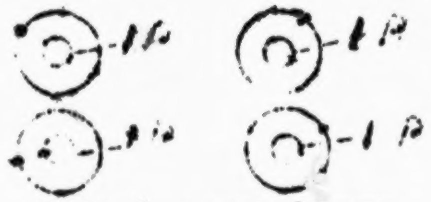


a. Electron: a negatively charged particle.
b. Proton: a positively charged particle found in the nuclei of atoms
c. Neutron: an uncharged particle found in the nuclei of atoms.

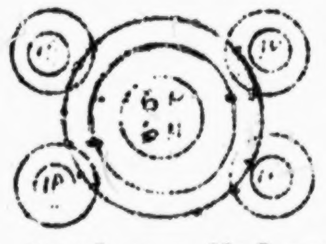
B. Molecule: a unit of matter consisting of two or more atoms held together in a covalent bond.

Methane Molecule


Carbon Atom



4 Hydrogen Atoms



Methane Molecule (CH_4)

The structure composed of atoms which share electrons, with the result that all orbits have been satisfied such as the methane molecule shown above is referred to as a molecule.

C. Ion: an atom which exhibits either a positive or a negative charge. It has lost or gained electrons and thus has an electrical charge.

Matter

1. Matter is electrical in nature.

2. Matter is composed of small units called atoms.

    a. Atoms are composed of fundamental particles, the most well known of which are protons, which bear a positive charge; electrons, which bear a negative charge; and neutrons, which bear no charge.

3. Matter is normally found in nature in molecular form rather than in atomic form.
4. Matter can be transformed into energy.
5. Matter can be measured by volume, weight, mass and energy.

Energy

1. The sun is the ultimate source of energy for most organisms.

2. Energy can be stored in matter.
3. Energy cannot be created or destroyed, but can be transformed into matter, and matter into energy, in an endless chain.
4. Chemical changes are accompanied by energy changes (respiration).
5. Electricity, heat, light are forms of energy.
6. Energy is measured in units called calories or in units called B.T.U.'s.
7. Energy is required by all living things for all activities of life.

VI. REFERENCES.

California State Department of Education, Biological Principles in Agriculture, Superintendent of Public Instruction, 1963.

Biological Science Curriculum Study, Molecules To Man, Blue Version, Houghton-Mifflin Company, Boston, Mass. 1963.

Biological Science Curriculum Study, High School Biology, Green Version, Rand McNally and Company, Chicago, Ill., 1963.

ABILITIES: To develop the ability to:		Assign. No.	UNDERSTANDINGS: To develop the understanding of:	
11	Identify retailing activities	3	11	Types of retailing activities
12	Identify retailing functions	3	12	Types of retailing functions

Business Procedures

ABILITIES: To develop the ability to:		Assign. No.	UNDERSTANDINGS: To develop the understanding of:	
13	Use sale tickets	4	13	Types of sale tickets
14	Use credit in selling	4	14	Types of credit instruments and credit policies
15	Determine selling prices	4	15	Principles of merchandise pricing
16	Use business forms	4	16	Types of business forms
17	Take inventory of stock	4	17	Types of stock inventories
18	Receive merchandise	4	18	Principles of receiving merchandise
19	Stock merchandise	4	19	Principles of stocking merchandise
20	Use a checkbook	5	20,21	Types of cash and expense records
21	Use a cashbook			
22	Record invoices	5	22	Types of purchases and accounts payable records
23	Compute inventory records	5	23	Types of inventory records
24	Use stock control records	5	24	Types of stock control records
25	Use an income statement	5	25	Content of income statements
26	Use a balance sheet	5	26	Contents of balance sheet

Agricultural Supply, Sales and Service Occupations

Assignment
Sheet No. 1

CAREER OPPORTUNITIES

Many employment opportunities exist in the sales, supply and management area of agricultural business. The occupations in this area are closely related to on-farm production problems. Training in agriculture and business is highly desirable for individuals who enter these occupations.

The farmer more and more buys goods and services from others of the agribusiness team to help him with the production of food and fiber. In the feed industry alone there are 6,000 manufacturing plants and 25,000 dealers who employ over 200,000 persons. Of these employees 40,000 are required just to handle the job of feed sales.

In looking forward to future jobs it is important to consider the type of work you will be doing. To have job satisfaction it is important to choose a career that you enjoy. If you have an interest in agriculture and business, the chances of your success in the sales, supply and management areas of agricultural business are very favorable.

Assignment:

1. Read the reference listed below.
2. Answer the questions in the question manual and turn in this assignment by ______________________.

Reference:

A. Hoover, Norman K. Handbook of Agricultural Occupations, The Interstate Printers & Publishers, Inc., Danville, Ill. 1963. pp. 117-131

Suggested learning activities:

1. Visit several agricultural supply businesses in your local community and observe the different jobs that the employees perform

2. Intervies several employees in the sales and service areas of the business and obtain the following information:

    1. What functions they perform.
    2. The years they have worked at their present job.
    3. The wage each employee is being paid.
    4. Their likes and dislikes about their work.
    5. The amount of time they spend on the job each day.
    6. What special qualifications they possess that makes them qualified for their jobs.
    7. What their career plans are and how they plan to attain them.

Teachers Key
Assignment
Worksheet No. 1

CAREER OPPORTUNITIES

True-False

1.	T	A-117
2.	F	A-118
3.	T	A-119
4.	F	A-119
5.	T	A-120
6.	T	A-120
7.	T	A-120
8.	F	A-121
9.	T	A-123
10.	T	A-122
11.	F	A-126
12.	T	A-126
13.	T	A-125
14.	F	A-128
15.	T	A-128

Multiple Choice

1. c the work involves a wide variety of activities A-117

2. d a college education is necessary for advancement A-120

Listing

1. a. county store clerk
   b. farm hardware and equipment store employee
   c. feed mill employee
   d. farm cooperative service store employee
   e. farm equipment and supplies salesman
   f. truck driver for a feed mill or farmer cooperative
   g. truck driver for a rural gasoline and oil distributor A-117

2. a. make sales
   b. keep records
   c. take inventory
   d. stock shelves
   e. display produce
   f. deliver orders
   g. janitorial duties
   h. order from salesman
   i. purchase produce from farmers A-118

3. a. like meeting people
   b. pleasing personality
   c. trustworthy
   d. willing to accept responsibility A-119

4. a. small hardware
   b. small parts for implements
   c. paints
   d. hand tools
   e. small power tools
   f. garden tools A-121

5. a. sells feed to retail customers
   b. mixes and grinds feed
   c. handles cash and credit transactions
   d. performs some maintenance and clean-up duties
   e. unloads cars, loads trucks, handles sacks in storage and processing
   f. operates mixing and grinding machinery
   g. delivers feed, keeps records A-121

6. a. calls on prospective buyers
   b. completes sales arrangements
   c. installs equipment or supervises its installation
   d. services equipment, or sees that it is serviced
   e. calls on customers and collects on accounts
   f. responsible for exhibitions, and other forms of advertising A-126

Assignment
Worksheet No. 1

CAREER OPPORTUNITIES

True-False

Directions: The following statements are either true or false. If the statement is true, draw a circle around the letter "T". If it is false, draw a circle around the letter "F".

T F 1. Farm supply businesses differ and there is considerable overlap in the variety of items offered for sale.

T F 2. Serving as a clerk in a small store is a highly specialized job.

T F 3. Working relationships in a small store are close.

T F 4. Country stores usually have shorter hours than urban stores.

T F 5. Promotions of employees in a country store usually are a result of the quality of work performed, the desire to assume responsibility, and interest in the business.

T F 6. Employees in a hardware store should have a knowledge of the uses of a wide variety of farm supplies.

T F 7. Employment in a farm hardware and equipment store is usually steady and pleasant.

T F 8. The work of the feed mill employee has little variation.

T F 9. The feed mill employee should like working with machinery, and possess good health and a strong body.

T F 10. The grinding and mixing phase of feed mill employment requires a tolerance of dust.

T F 11. Persons with physical handicaps should not consider farm sales positions.

T F 12. Farm experience aids the sales person in talking with customers.

T F 13. A farm supply employee who desires advancement should make an attempt to attend evening classes if possible.

T F 14. A truck driver for farm supply businesses spends all his time hauling supplies.

T F 15. The truck dirver should enjoy working with farm people and be able to do considerable lifting.

Multiple Choice

Directions: In the space at the left of each statement, write the letter of the item which will provide the correct answer to complete the statement.

______ 1. A common characteristic of all farm supply occupations is that:
- a. they all sell feed
- b. they all sell fertilizers
- c. the work involves a wide variety of activities
- d. they all require a knowledge of mechanics

______ 2. Which of the following does not pertain to farm supply occupations:
- a. the hours are regular and the employment is steady
- b. a background of high school agriculture and business is beneficial
- c. all jobs require a knowledge of a wide variety of supplies
- d. a college education is necessary for advancement

Listing

Directions: List the items called for in each of the following. Select your answers carefully.

1. List some of the common sales, supply and management occupations:

a.

b.

c.

d.

e.

f.

g.

2. The clerk in a small store will ordinarily perform some of the following activities:

a.

b.

c.

d.

e.

f.

g.

h.

i.

3. The sales person in a country store should possess the following personal qualities:

a.

b.

c.

d.

4. Employees in a farm hardware and equipment store should have a knowledge of the following items:

a.

b.

c.

d.

e.

f.

5. The feed mill employee will usually perform the following work:

a.

b.

c.

d.

e.

f.

g.

6. The farm equipment and supplies salesman usually performs the following activities:

   a.

   b.

   c.

   d.

   e.

   f.

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STUDENT WORKSHEETS
ON
PRINCIPLES
IN
ANIMAL SCIENCE
PLANT SCIENCE
SOIL SCIENCE

(Supplement to Publication No. 1)

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT

Department of Agricultural Education
Dr. James T. Horner, Chairman
University of Nebraska
In Cooperation With
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

VT010311

This publication was prepared in furtherance of a project supported by a grant from the U.S. Department of Health, Education, and Welfare, Office of Education, entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming". The project was initiated by the Department of Agricultural Education of the University of Nebraska, and has been designated DAVR Project No. 001-65, and Contract No. OE-05-85-020.

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Ernest R. Peo, Jr.	Consultant
Kenneth G. Schmidt	Consultant
Dave C. Williams, Jr.	Consultant

TO THE STUDENT

The discussion questions in this publication have been developed to supplement the material presented in the publication entitled "Principles In Animal, Plant and Soil Science".

This publication consists of a variety of questions which are designed to briefly summarize the materials presented in each principle area. The questions are of a discussion type, multiple choice, true and false or completion. These questions attempt to emphasize the important points covered in each principle area. Upon completion of the questions, the student should have a rather complete resume of the information pertaining to animal, plant and soil science.

The questions may be answered by writing directly in this publication or by placing answers on additional sheets of paper.

It is recommended that each section of this publication be completed after the entire principle area has been discussed and practical applications have been made by the teacher and students in the classroom and shop.

Assignment
Worksheet No. 1

MATTER AND ENERGY

Assignment:

1. Review your class notes.
2. Review the following references.
3. Answer the following questions.

References:

1. Class notes
2. Biological Science Curriculum Study, Molecules To Man, Blue Version, Houghton-Mifflin Co., Boston, Mass., 1963, pp. 87-94
3. Biological Science Curriculum Study, High School Biology, Green Version, Rand-McNally Co., Chicago, Ill., 1963, pp. 7-19

Discussion Questions:

1. What is the principle of matter and energy?

2. What change occurs when feed is consumed by livestock?

3. What change occurs when fertilizer is taken into a plant?

4. Give 3 examples of living matter.
   1. 2. 3.

5. Give 3 examples of non-living matter.
   1. 2. 3.

6. Matter is composed of small units called ____________________. These units are composed of fundamental particles called __________, which are positively charged; ______________ which are negatively charged; and ____________ which bear no charge.

7. Under certain conditions, ______________ may be removed from or added to an atom, giving it a positive or a negative charge. These particles revolve about the nucleus in shells.

8. An atom which is either positively charged or negatively charged is called an ________________.

9. Atoms which share electrons, with the result that all orbits have been filled, are called ____________________.

10. The ___________________ is the ultimate or beginning source of energy for most organisms.

11. Anhydrous ammonia will not leach out of the soil because it is a _____________________ charged ion and clay particles are ___________________ charged.

Assignment
Worksheet No. 2

LIVING MATTER
vs.
NON-LIVING MATTER

Assignment:

1. Review your class notes.
2. Review the following references.
3. Answer the following questions.

References:

1. Class notes
2. Biological Science Curriculum Study, High School Biology, Green Version, Rand-McNally, Chicago, Illinois, 1963, pp. 377-409
3. Hughes, Harold D., and others, Crop Production Principles and Practice, The MacMillan Company, pp. 66-7
4. Wilson, H. K. and A. C. Richer, Producing Farm Crops, The Interstate Printers and Publishers, Danville, Illinois, 1960, pp. 28 & 130

Discussion Questions:

1. What is the principle of non-living matter?

2. Non-living matter carries on most of the processes of living matter except the process of ______________________.

3. Why do clay particles and anhydrous ammonia fertilizer have a desirable relationship when placed together in the soil?

4. Water continually alters its behavior by __________________ and __________________.

5. List 5 examples of non-living matter.

6. Non-living matter will move, expand, burn and will undergo chemical changes. T or F

7. What is the principle of living matter?

8. List 3 main differences in plant and animal cells.

9. What is a cell?

10. What is the ultimate source of energy for most living organisms?

11. Cells differ in structure and function in order to carry on the life processes. What are the functions of various cells?

12. Why do living organisms cells (1) differ in response to stimulation and (2) in abilities and capacities?

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TEACHER'S KEY

FOR

STUDENT WORKSHEETS

ON

PRINCIPLES

IN

ANIMAL SCIENCE
PLANT SCIENCE
SOIL SCIENCE

(Supplement to Publication No. 1)

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TO THE TEACHER

This publication is designed to assist the Vocational Agriculture teacher in checking the answers written by the students in the publication entitled "Students Worksheets On Principles In Animal, Plant and Soil Science".

The purpose of the student worksheet is to provide the student an opportunity to review the material studied in each principal are: The key to teaching agriculture with the basic underlying principle approach is to allow the students to discover the basic underlying principle. Hence, the student worksheets should not be used until the entire principle area has been completed. After students have discovered the principle and made appropriate applications in animal plant and soil science, the worksheets will provide a review of the principle area. Therefore, the worksheets on each principle area should be given to the student one-at-a-time.

The teacher's key provides the answers for the questions on the student worksheets. The key may be used by the teacher or student to correct the answers.

Answer Key
Assignment
Sheet No. 1

MATTER AND ENERGY

Answers:

1. All things living and non-living are either matter or energy, or a combination of matter and energy.

2. It is changed from matter to energy.

3. It becomes usable by the plant and changes from matter to energy.

4. 1. Corn plant (Green) 2. Cow 3. Hog

5. 1. Soil 2. Water 3. Metal

6. atoms
   protons
   electrons
   neutrons

7. electrons

8. ion

9. Molecule

10. Sun

11. Positively
    Negatively

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PRINCIPLES
IN
AGRICULTURAL MECHANICS

Roland L. Peterson

and

James T. Horner

Cop 8 OE 4

Publication No. 4 - 1966

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
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Dale G. Zikmund	Research Associate
W. Forrest Bear	Consultant
Ralph W. Canada	Consultant
Sidney S. Sutherland	Consultant

FOREWORD

This handbook is the fourth publication prepared expressedly for use in a study entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming", which is being conducted by the Department of Agricultural Education, Agricultural Experiment Station, College of Agriculture and Home Economics, University of Nebraska in cooperation with the State Board for Vocational Education, State of Nebraska. One phase of the study deals with curriculum organization of vocational agriculture instruction. Specifically, it is desired to compare instruction based on the principles underlying agriculture with the instruction based on the activities of agricultural workers. The immediate point of interest is to determine which plan of instruction organization is most effective in preparing high school students for entry into off-farm agricultural occupations.

The development of this publication included recommendations made by those in attendance at a conference on the principles approach to providing instruction in vocational agriculture held at the Center for Leadership and Research Development in Vocational and Technical Education, Ohio State University, Columbus, Ohio on April 27-28, 1966. Additional guidance as to the determination of the specific principles and their content was given by Dr. Ralph Canada, Professor of Agricultural Education, Colorado State University; Dr. Forrest Bear, Department of Agricultural Engineering, University of Minnesota; Sidney Sutherland, Professor of Agriucltural Education, University of California, Davis; Professor M. Garfield McCreight, Professor of Agricultural Education, University of Nebraska; and Professor Urban E. Wendorff, Professor of Agricultural Education and Agricultural Engineering, University of Nebraska.

In addition to expressing appreciation of Messrs. Canada, Sutherland, Bear, McCreight, Wendorff and those in attendance at the Ohio Conference, it is appropriate that recongnition be given to Roland L. Peterson, Research Associate, Department of Agricultural Education, University of Nebraska, who has been responsible for the organization and development of the content of the handbook. Acknowledgement also is due Mr. Gary Day, Nebraska State Department of Education, Science and Mathematics Consultant, who has served as a consultant to Mr. Peterson; and Dr. John Coster, Director, Center for the Study of Occupational Education, North Carolina State University, who so ably directed this pahse of the project while director of the total project at the University of Nebraska

Alan A. Kahler

PREFACE

The area of mechanics has a great deal of importance today in the agricultural industry. During the past fifty years one of the greatest changes on the agricultural scene has been the mechanization of farms and farming operations. As machines have replaced animal and human power the investment in machinery and equipment has increased. Today, investments in machinery and equipment constitute a substantial portion of a farmer's total investment in a farm business. Numerous businesses are manufacturing and servicing farm machinery so vital to the efficiency of the American agricultural industry. With the growing importance of mechanics to agriculture, it is apparent that students preparing for careers in agriculture should be provided with a background in mechanics as it applies to agriculture. With constant changes in technology, evidence seems to point to the fact that students need a background in the basic underlying principles which remain fairly constant regardless of new developments in machinery. Hence, this guide was developed to aid teachers in teaching basic underlying physical principles and their application to agriculture. A long accepted fact is that "principles should be taught with applications"; that teaching is most effective when these two important kinds of content are presented in the closest possible relationship with each other. The "principle" approach lends itself to instruction for understandings, essential to the ability to make appropriate applications.

Each unit in this publication is based upon the most important physical principles that have applications to agriculture. Numerous physical principles were not included because it was felt the principles included in this publication covered them to some extent or they had only minor applications in areas of agriculture.

A review of materials in the area of physical principles revealed that several initial efforts had been developed at the University of California, Davis, under the direction of Dr. Orville Thompson and Professor Sidney S. Sutherland. The efforts were in the form of Masters of Education reports. Much credit is due to the following men for initial development: Mr. W. G. Seargeant for a report entitled "Physical Principles of Heat, Light, Electricity and Fluids in Motion Applicable to Farm Mechanics," also to Mr. Melvin J. Elkins and Mr. Sid Johnson for a report entitled "Principles Taught in Agricultural Mechanics." A great deal of credit is due to a panel of consultants who suggested principles, applications and demonstrations. These men also reviewed the preliminary efforts of this publication. They are as follows:

Professor Forrest Bear - University of Minnesota
Professor Ralph W. Canada - Colorado State University
Professor M. G. McCreight - University of Nebraska
Professor Sidney S. Sutherland - University of California (Davis)
Professor U. E. Wendorff - University of Nebraska

Special recognition is due Dr. John K. Coster for his helpful suggestions in the early stages of the development of this publication, Mr. Gary Day of the Nebraska State Department of Education for his assistance in reviewing and suggesting changes in the development of this guide, and to Professor U. E. Wendorff for providing lesson plan materials developed under his guidance and leadership.

The material was taught experimentally during the 1966-67 school year in the following Nebraska schools:

Teacher	School
James Osborn	Arnold
Irving Wedeking	Aurora
Thomas Mattson	Blue Hill
Neal Smith	Clarkson
Edward Stich	East Butler
Stanley Elsen	Perkins County (Grant)
Jess Vetter, Jr.	Hemingford
Hayden Owens	Howells
Don Tapley	Hyannis
Sideny Borcher	Newman Grove
Leon Deunk	George Norris
Donald Blecha	Osmond
James Boyle	Superior
Donovan Benson	Syracuse
Ted Ward	Verdigre

Also credit is due the following Minnesota Vocational Agriculture Teachers who, under the guidance of Dr. Forrest Bear, developed useful materials on physical principles: Wayne Torgerson, Ray Grundmeier, John Murray, Bernard Nelson, Dary Talley, Robert Rohner, Peter Fog, Vern Taylor, Jay L. Jensen, Kenneth Anderson, Wallace Payne, Harlin Hecht, Rodger Palmer, Leroy Swanson, Kayle Becker, Gary Schaller, Kenneth Stassen, Lyle Nelson, Roger Fransen and Howard Brockman and Roger Piehl, Vocational Agriculture teachers from Wisconsin.

A great deal of recognition is due the following Nebraska Vocational Agriculture Teachers who developed portions of the material: Edward Stich, James Boyle, Donovan Benson, James Osborn, Sidney Borcher, Norval McCaslin, Richard Douglas, Ray Becker and Darrel Siekman, an undergraduate assistant, also spend considerable time and effort in gathering material for this publication.

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INTRODUCTION

The material in this publication may be taught in a variety of methods. A method of teaching will be suggested to provide teachers with a guide in presenting this material.

The material presented in each principle unit is categorized as follows: (1) principle, (2) objectives, (3) application to agriculture, (4) demonstrations, experiments, problems, (5) definitions and facts and (6) references. Two basic approaches can be used in its presentation. An inductive approach is the most effective way of introducing the unit covered by the principle and/or principles. The key to inductive teaching is the withholding of any statement of the principle until the students have had an opportunity to observe, study and consider several instances in which the principle is involved. The teacher should provide instances for discovery of the principle through the use of demonstrations, experiments or problems suggested and presented by the teacher or by field observations. Before introducing each demonstration, experiment, or problem the students should be asked "What will happen?" and "Why does this occur?". The answer to these questions will eventually lead students to the discovery of the underlying principles. Hence, students have been led inductively from the observed or demonstrated situation, to the cause or causes of the situation. At this point a deductive approach should be used to take the students from the known situation to its applications to agriculture through the use of problem solving.

An example of the preceding procedure may be illustrated using the unit on Flow of Fluids and Gases. The suggested demonstration may be the sixth demonstration in which a straw is submerged about half way in a jar of water. A stream of air is blown across the top of the straw causing the water to move up the straw into the stream of air. This is an observed effect and students may be asked why this happens. Eventually the students will suggest that this phenomenon is due to a lower atmospheric pressure in the air stream, causing the atmospheric pressure to force the water into the stream. It is then an easy step to reveal Bernoulli's principle of flow of fluids and gases which states "Whenever a gas or liquid is flowing through a closed flow path the pressure at or near the center of the stream is lower than the pressure at the outer edges of the stream. The greater the velocity of flow, the less the pressure." On the basis of this discovery, students may be directed to apply this principle in agricultural mechanics. The carburetor on the farm tractor operates on this principle. Students may apply the principle to understanding the function of a carburetor. Its adjustment and maintenance then comes as a result of this understanding.

Through this process students have discovered the underlying principle inductively and have deductively applied the principle to real life situations. The student is made aware of the relationship of Bernoulli's principle and one effect in agricultural mechanics.

The following outline is a suggested procedure for teaching the material in this publication:

Steps	Key Points
1. Teach inductively.	A. Withhold stating the principle.
	B. Allow students to discover the underlying reasons.
2. Introduce the principle by observing known situations and/or problems.	A. Recall situations in production agriculture in regard to the principle.
	B. Teacher and/or students conduct experiments.
	C. Teacher conduct a demonstration.
	D. Teacher presents problems.
3. Reveal the principle.	A. Draw conclusions from the students that each demonstration has something similar.
	B. Summarize the observations by stating the principle.
	C. Give the students the definition of the principle.
4. Teach the facts and definitions regarding the principle.	A. The facts give the students background about the principle.
	B. Facts and definitions will aid in a further understanding of the principle.
5. Apply the principle to agriculture.	A. Teach the problems in production agriculture involved in the principle.
	B. Teach the skills and knowledge needed by the students related to the principle.
	C. Use various teaching methods in providing the students with the knowledge and skills involved in the principle.
6. Provide the students with worksheets for individual study.	A. Allow students to complete worksheets for each principle.
	B. Check with teachers key.

TERMINOLOGY

The question may be asked "What is a principle and how do principles differ from a concept, a rule or a fact?" According to Sutherland and Sams,

> A principle is a fundamental truth, a law of conduct that has general applications and is a basis for action. It is a generalization based on facts and on elements of "likeness" common to a number of situations. Since a principle is a generalization, there are sometimes minor exceptions to it, but it still has general application.[1]

Following is a comparison of a principle with a rule, a fact, a concept, or a law.

> A rule is a specific direction or regulation for action, and is generally based upon a principle or principles.
>
> A fact simply states something that actually exists or has been done.
>
> A concept is a generalization made by an individual. It is an idea, a mental image based upon an understanding of all that is associated with or suggested by a term.
>
> A law is a generalization that, so far as is known, is invariable under given conditions.[2]

---

[1] Sutherland, Sidney S. and W. Earl Sams, Biological Principles in Agriculture, California State Department of Education, and University of California, Davis, California, 1963. p. 2.

[2] Ibid, pp. 2-3.

THERMODYNAMICS

I. PRINCIPLE:

A. First law of thermodynamics

1. When heat is transformed into any other form of energy, or when other forms of energy are converted into heat, the total amount of energy and heat is conserved.

B. Second law of thermodynamics

1. Heat flows from a region of high temperature to one of low temperature and can do mechanical work in the process. Heat cannot flow in the opposite direction unless work is done to accomplish this.

II. OBJECTIVES:

A. To develop an understanding of the principal parts of an internal combustion engine.

B. To develop an understanding of the types of fuels to use in an internal combustion engine.

C. To develop an understanding of the function of an internal combustion engine.

D. To develop the ability to adjust the valves spark plugs and valve timing of an internal combustion engine.

E. To develop the ability to service the valves, spark plugs, and valve timing of an internal combustion engine.

III. APPLICATIONS TO AGRICULTURE

Problems or topics:

A. What are the principal parts of an engine?

1. Discuss the problem in the classroom and consider the following:

    a. cylinder
    b. piston
    c. cylinder black
    d. cylinder head
    e. connecting rod
    f. wrist pin
    g. piston rings
    h. crankshaft
    i. camshaft
    j. valves

(1) intake valves
(2) exhaust valves
(3) push rod
(4) rocker arm

k. valve spring
l. valve rotator
m. timing device
n. flywheel
o. crankcase
p. spark plug

B. What factors should be considered in storing gasoline, diesel fuel, and LP gas?

1. Discuss the problem in the classroom and consider the following factors.

a. Storing gasoline

(1) Evaporation - underground tank or a pressure.

(2) Condensation - underground tank or valve or cap or a pressure valve.

(3) Gum formation - do not let the fuel or cap get old.

(4) Safety precautions - keep away from flame, buildings.

b. Storing diesel fuel

(1) The important items is clean fuel.

(2) The storing container should have a drain.

(3) After tank is filled allow 24 to 48 hr. for water and sediment to settle before withdrawing fuel.

c. Storing LP gas

(1) Above ground tanks are recommended for leak detection.

(2) Never use flame for leak detection.

(3) Never fill tank 100 per cent full, as expansion must be allowed for as temperature increases.

(4) LP gas is heavier than air, therefore it is likely to accumulate in low spots. Thus, never fill a tank over low spots or pits as an explosion could occur when starting an engine.

C. What procedure should we follow in making valve-clearance adjustments?

1. Discuss the problem in the classroom and provide students with practical experience.

Steps	Key Points
1. Read the operator's manual	1.1 Determine if value clearance should be set with engine hot or cold. 1.2 If checked while hot, then operate engine until temperature gage shows "normal" 20 to 30 minutes.
2. Remove tractor parts that interfere with valve cover removal	2.1 Remove possibly air-cleaner cap, muffler head, fuel tank. 2.2 Remove dirt and grease from valve cover and spark plugs.
3. Remove valve cover	3.1 Remove nuts or cap screws 3.2 Be careful if you plan to use the old gasket.
4. Avoid accidental starting of engine	4.1 Diesel engines shut off the fuel supply. 4.2 Spark-ignition engines-disconnect center terminal to distributor.
5. Check cylinder head for tightner	5.1 A torgue wrench is best if available. 5.2 If tightened after adjustment this may change the valve clearance.
6. Slowly turn crankshaft until piston in number 1 cylinder is at top dead center (TDC) of compression stroke	6.1 At TDC on compression stroke, both intake and exhaust valves are closed. 6.2 Push rod followers are on the low side of the cams. 6.3 No. 1 cylinder is next to the radiator on up right engines and on horizontal engines, is next to fly wheel. 6.4 For spark and diesel engines, TDC of compression may be found by: a. Use of timing marks on the fan pulley or flywheel. (Check operator's manual to have the correct marks). b. Watch the intake valve on the No. 1 cylinder. (When closes turn crank ½ turn.

	6.5 On spark-ignition engines, TDC of compression stroke may be found by: a. Watch the No. 1 spark plug wire and turn the crank until spark jumps the gap between the wire and the block. b. Place your thumb over the spark plug opening and crank engine until end of compression stroke no further pressure felt.
7. Check valve-clearance	7.1 Determine correct feeler-gage thickness by checking your operators manual. 7.2 Insert gage between valve stem and rocker arm of both valves. 7.3 First valve is exhaust second is intake. 7.4 Valves are arranged in pairs. 7.5 If clearance is correct proceed with step 9, if it is not proceed step 8.
8. Adjust the valve clearance	8.1 Loosen adjusting - screw lock nut on valve rock arm. 8.2 Turn adjusting screw with screw driver until feeler gage will just slip in and out of gap. (Be sure to use a cold setting if engine is cold) 8.3 Hold adjusting screw with screw driver and tighten lock nut with wrench. 8.4 Recheck with feeler gage.
9. Determine which cylinder fires next.	9.1 Determining firing order a. Check operators manual b. Commonly stamped on side of engine block.
10. Crank engine until next cylinder in firing order is on compression	10.1 With 2 and 4 cylinder engines turn crankshaft ½ turn. 10.2 With 6 cylinder engines turn 1/3 turn. 10.3 Adjust valves following the above steps and continue with the remaining cylinders.
11. Reassemble the engine after the valve adjustment	11.1 Start engine and check rocker arm lubrication. 11.2 Some manufacturers suggest rechecking valve clearance. 11.3 Install spark plugs if applicable

11.4 Replace valve cover gasket.
11.5 Replace valve cover.
11.6 Install other tractor parts that were necessary to remove.

D. What factors should be considered in replacing gaskets in an engine?

1. Discuss the problem in the classroom and consider the following factors.

a. Type of gasket

(1) Cork
(2) Rubber
(3) Metal
(4) Pressed cardboard
(5) Combinations of the above

b. Gasket shellac or sealer (Helps gasket to seal properly thus avoiding leaks)

c. Follow tightening specifications (Rubber gaskets for example can be torgied down many times until the gasket is split and forced out of place)

d. Check gasket for proper alignment

e. Clean surfaces that are to be in contact with the gasket. (Remove all traces of the old gasket)

E. What procedure should be followed in servicing the fuel system in a spark ignition engine?

1. Discuss the problem in the classroom and provide students with practical experience.

Steps	Key Points
1. Check fuel flow	1.1 Improperfunctioning of the flow fuel from the tank through the shutoff valve to the sediment bowl and into the strainer before entering the sediment bowl can result in: a. Engine's failure to start. b. Stopping after operating a short time. c. Lack of power. 1.2 The most common of the above failures are: a. Water and ice in the tank. b. Closed or partially closed shut-off valve. c. Improper functioning of sediment bowl.

	1.3 Dirt, gum, sharp bends or dents in tubing. 1.4 Straines filled with dirt.
2. Clean the sediment bowl and filter.	2.1 Close fuel tank shut-off valve. 2.2 Loosen jam nut and remove bowl by twisting. 2.3 Clean sediment bowl and screen. Note: Rags and waste saturated with oil or cleaning fluids are a fire hazard. 2.4 While sediment bowl is disassembled, open tank shut-off valve and check for flow, water and dirt. 2.5 Reassemble the strainer, be sure cock gasket is in good condition. 2.6 After tightened jam nut check for leake. 2.7 Clean fuel strainer every 250 hours or once a month.
3. Inspect fuel tank cap	3.1 Wash with kerosene or fuel oil. 3.2 Blow out vent. 3.3 Never push wooden objects through vent opening.
4. Check the tank and fuel line	4.1 If flow of fuel is sluggish, after above steps have been completed, it is usually due to sediment, dirt, or gum in tank bottom. 4.2 Drain fuel from tank and place in closed container. 4.3 Disconnect necessary tubing and remove fittings. 4.4 Rinse tank with kerosene or fuel oil. (To clean gum from tank use commercial gum solvent, half & half alcohol and benqol or acetone.) 4.5 Drain well and assemble. 4.6 Clean tubing and fittings. 4.7 Replace damaged parts. 4.8 Check for leaks.
5. Inspect fuel line and screen	5.1 Remove fuel from carburetor. 5.2 Remove fuel line fitting which usually contains the fuel line screen. 5.3 Clean screen and replace. 5.4 Check for leaks.

F. What factors should be considered as reasons for detonation, "spark knock", or "pre-ignition?"

1. Discuss the problem in the classroom and consider the following factors.

   a. chemical composition of fuel
   b. compression ratio
   c. ignition timing
   d. mixture ratio
   e. water-jacket temperature
   f. mixture temperature
   g. working conditions (load, speed, etc.)

   Engines that knock may result in burned valves and pistons, burned out head gaskets and ruined spark plugs. An engine can become a complete wreck because of detonation.

G. What factors should be considered in selecting spark plugs?

1. Discuss the problem in the classroom and consider the following factors.

   a. Operating Conditions

      (1) Light loads with excessive idling use hot plugs
      (2) Heavy continous load used cold plugs

   b. Kind of fuel used

      (1) Kerosene or distillate use a hotter plug than gasoline
      (2) LP - gas uses a colder plug than gasoline

   c. Engine Design

      (1) The length or reach of a plug is affected.
      (2) If longer reach plugs are used than recommended, they will extend into the combustion chamber and interfere with piston and valve action.
      (3) If plug with too short a reach are used, the spark will be shielded resulting in improper combustion and the exposed threads in the cylinder head will accumulate deposits.

H. What procedure should be followed in changing fuel filters on a compression ignition engine?

1. Discuss the problem in the classroom and consider the following.

   Procedures are the same for the first, second and third-stage filters. The first-stage filter needs more frequent replacing or cleaning. The second stage filter may be used longer if the first-stage filter is properly serviced. The third-stage filter is usually replaced when the tractor is overhauled.

Steps	Key Points
1. Turn off fuel supply	1.1 The shut off valve is usually located under or near the tank.
2. Clean outside of filter	2.1 This keeps dirt from entering the fuel system.
3. Remove old filter	3.1 Drain fuel from filter. 3.2 Most filters bowls are held by stud bolts. 3.3 Clean inside of filter bowl unless it is selfcontained.
4. Install cleaned filter or new disposable filter element	4.1 Inspect all gaskets and if damaged replace. 4.2 Tighten filter assembly. 4.3 Replace or tighten drain valve.
5. Bleed the fuel line	5.1 Open bleed valve on top of filters. 5.2 Open fuel tank valve. 5.3 Some tractors are equipped with a hand prime pump. 5.4 Some engines may have a by pass line and valve. 5.5 Close bleed valve.

I. What factors should be considered in selecting fuels for tractor engines?

1. Discuss the problem in classroom and consider the following:

    a. Engine Design

        (1) High compression-most tractors are not high compression and do not require premium fuels. (9.0-10.5:1)

        (2) Moderate compression - Today the majority are in this range using regular gasoline. (6.0-8.5:1)

        (3) Low compression - Kerosene, tractor fuel and low grade gasoline can be used in these engines. (4.0-5.0:1)

    b. Seasons of the year

        (1) Fuel manufacturers will change the fuel according to the season, with a lighter fuel for winter and a heavier fuel for summers.

        (2) For diesel fuel it is advisable to use No. 1 in winter and No. 2 in summer.

c. Cost

(1) Diesel is cheaper however the initial tractor cost and overhaul is higher.

(2) LP-gas may be better since manufacturers are conforming to standards for the fuel instead of each manufacturer's fuel being different.

(3) Gasoline doesn't figure a lot higher than diesel when the tax refund is subtracted.

d. Fuel characteristics

(1) Gasoline will produce more power than diesel or LP-gas, however tractor manufacturers are increasing the size (cu. in.) of the diesel and LP-gas engine to off-set the power loss & a certain model of tractor will have the same power no matter what fuel is used.

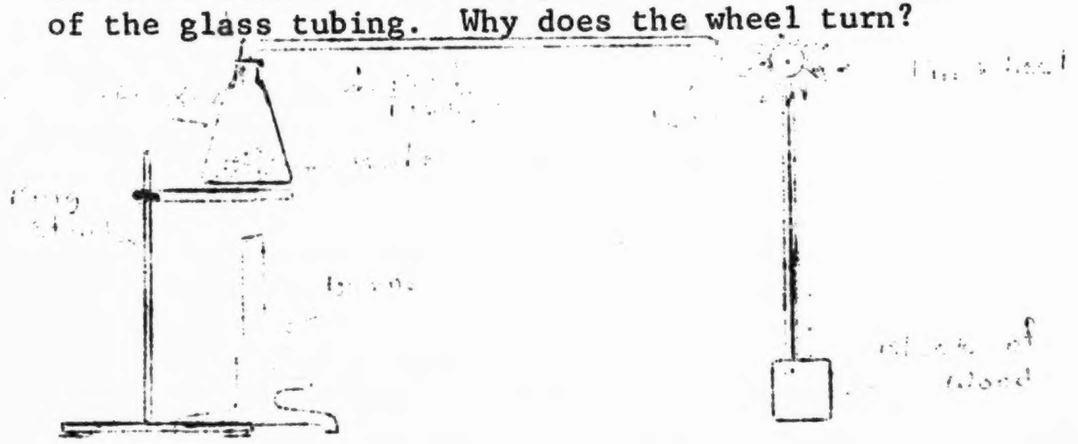
(2) Gasoline produces more BTU/gallon than LP-gas, however diesel produces more BTU/gal than LP-gas and gasoline.

(3) Alchohol and kerosene are not used very much today.

Note: The following 35 minute film by John Deere and Co., "For Better Tractor Performance," may be useful in the application of this principle to agriculture.

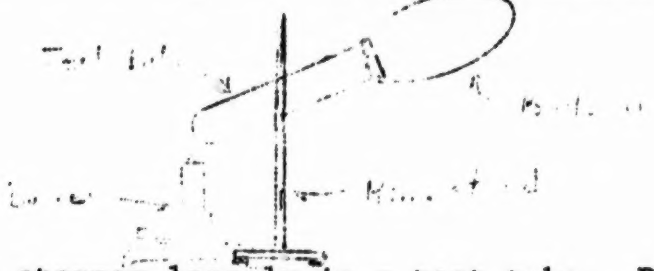
IV. DEMONSTRATION, EXPERIMENTS, PROBLEMS:

A. Demonstrate the effects of heat being changed into mechanical energy. Fill a 250 ml. Erlenmeyer flask about one-half full of water. Place a one hole rubber stopper in the flask. Place a glass tube into the stopper and bend at a 90° angle. Place the flask on a holder and ring stand and heat the flask with a torch or burner. Place a pinwheel at right angles to the tip of the glass tubing. Why does the wheel turn?



The energy being produced by changing the water to vapor may be used as work. In the cylinder of an engine the change of expanding gases due to heating the compressed gas and air produces work by exerting a force on the piston and moving it.

B. Place a test tube in a clamp fastened to a ring stand. Place a rubber balloon over the end of the test and slowly heat the entire test tube. Note the increase in volume of the balloon due to the heat causing (the movement of molecules increases rapidly). Note the decrease in volume as the test tube cools. This same action occurs in a tractor or trailer tire in hot weather, causing a tire to appear properly inflated until cool weather when the tire appears flat. (This action also occurs on the face of a piston in an engine only in an increased manner.)



C. Place a stopper loosely in a test tube. Place a small amount of water in a test tube and heat the test tube slowly and evenly. Direct the end of the test tube away from all students. (The rapid movement of molecules, due to the increase in temperature should force the stopper out of the tube.) The stopper must be directed away from the students to avoid injury.

Test tube
Ring stand

The above three experiments have illustrated the action of heat and its ability to perform work. The action observed is similar to the action of molecules upon the face of a piston in an engine.

V. DEFINITIONS AND FACTS:

A. An internal combustion engine produces work by igniting and burning fuel in a closed cylinder.

B. Parts of an internal combustion engine:

1. The cylinder is the hole or tube in which fuel combustion occurs.

2. The piston is a small cylinder closed at one end that fits snugly into the cylinder.

3. The cylinder block is a metal box which contains a row or a series of cylinders or holes.

4. The cylinder head is bolted on top of the cylinder block closing the top end of the cylinders. The space in the cylinder head combined with the cylinders form the combustion chamber.

5. The connecting rod connects the piston to the crankshaft.

The wrist pin is a tubular steel pin that fits through the top end of the connecting rod attaching it to the piston.

7. The piston rings are expandable metal rings that are split at one point and fit into the grooves on the pistons. They fill the space between the piston and the cylinder wall and allow for expansion and contraction of the piston and cylinder wall. The following types of rings are used: (1) oil rings and (2) compression rings. The number of each type varies with the type of engine, diesel, L.P., gasoline, etc.

8. The crankshaft changes the reciprocating motion of the pistons into a rotary motion of a drive shaft. The lower end of the connecting rods are attached to the crankshaft.

9. The camshaft is a shaft the length of the block consisting of two eccentrics per cylinder and a gear to operate the distributor, oil pump and an eccentric which operates the fuel pump.

10. The valves allow the gases to enter and leave the cylinder at proper times. The intake valve allows the fuel-air mixture to enter the cylinder, and the exhaust valve allows the exhaust gases to leave the cylinder. The tappet rides on the camshaft and presses against the push rod which pushes against the rocker arm which in turn opens the valve. The push rod and rocker arm assembly are necessary in the overhead valve engine only. Some engines may be slightly different in the push rod and rocker arm assembly.

11. The valve spring closes the valve when the cam turns away from the tappet.

12. The valve rotator permits the valve to turn slowly when it opens and closes. It is used particularly on exhaust valves and lessens valve sticking.

13. The timing device may be either two gears or a chain connecting the crankshaft to the camshaft causing the valves to open and close at the proper intervals.

14. The flywheel is bolted to the rear of the crankshaft and acts as a "surge tank" for the motion, thus enabling a smoother engine operation.

15. The crankcase is a reservoir located in the lower portion of the engine which contains the oil supply for the engine.

16. The spark plug is a device which is provided with a small gap in the electrical circuit allowing a spark to jump across the electroder, thus igniting gases in the cylinder.

C. The usual type of gasoline tractor engine is known as the four-stroke cycle (four cycle) engine. A cycle may be defined as a series of events that are continually repeated in the same order. By definition, the four cycle engine has four separate and distinct strokes--the intake, compression, power, and exhaust strokes.

1. Intake stroke--As the piston moves downward, the intake valve opens and allows the air-fuel mixture to enter the cylinder. The air-fuel mixture enters the cylinder because of lower air pressure or a partial vacuum caused by the downward motion of the piston. When the piston has reached the lowest extent of its stroke the intake valve closes.

2. Compression stroke--The piston moves up the cylinder compressin the fuel-air mixture. As the piston moves upward, the temperature rises because of the increased pressure; this causes the fuel to burn more rapidly and efficiently when it is ignited by the spark plug. Just before the piston reaches the top end of its stroke, the spark plug ignites the fuel in the cylinder in the area between the top of the piston stroke and the engine head which is called the combustion chamber. The more the fuel-air mixture is compressed, the higher the temperature will be raised and an increased amount of energy will be released.

3. Power stroke--The burning fuel vapor produces an intense heat which rapidly expands the gases in the cylinder, forcing the piston downward. As the piston nears the bottom of the stroke the exhaust valve starts to open and when the piston reaches bottom dead center the exhaust valve is completely open.

4. Exhaust stroke--The hot gases are moved out of the cylinder as the piston moves up the cylinder. When the piston reaches the top end of its stroke, the exhaust valve closes.

D. An engine uses heated gases which expand to produce mechanical energy. As the piston moves up the cylinder on the compression stroke, the air-fuel mixture is heated as it is compressed. The air-fuel mixture is then ignited by the spark (in a spark ignition engine). The intense heat caused by this burning increases the speed of the molecules and their bombardment against the top of the piston drives it downward. As the air cools, the force decreases, hence another cylinder should fire. It is in this manner that an internal combustion engine converts chemical energy into mechanical energy.

E. A diesel engine operates in the same manner except that no spark plug is necessary to ignite the air-fuel mixture. Instead it is ignited by the intense heat caused by the very high compression (about 16 to 1). Precise amounts of fuel are injected into the cylinder just as the piston reaches the top of the compression stroke and is instantaneously ignited by intense heat caused by the high compression.

The higher the temperature and pressure of the vapor in the engine and the lower the exhaust temperature and pressure, the more efficient the engine will be. This is the reason why a diesel engine is more efficient than a gasoline engine (higher compression and temperature). This also explains why improving the exhaust system of an engine will increase its efficiency because the exhaust temperature is lowered.

F. The conversion of heat energy to mechanical energy is not a very efficient conversion and approximately one-third of the energy developed is used for work, one-third is lost in cooling and one-third is lost in the exhaust.

G. The main purpose of a fuel is to provide energy to expand the gases in the combustion chamber when the fuel is burned. Internal combustion engines are engineered to burn a certain type of fuel. (For example diesel, gasoline (regular or ethyl), tractor fuel.) Maximum engine performance can be achieved only if the proper fuel is used. The continued use of the wrong type of fuel may cause a loss of power, excessive fuel consumption, or a general decrease in overall efficiency and an increase in engine wear.

H. The common fuels presently used are gasoline, "liquified-petroleum gas," and diesel fuel. Several characteristics of engines and fuels must be considered to determine what type of fuel will be used for a specific engine.

PROPERTIES OF FUELS

Fuel	lbs. wt/gal.	Heat BTU lbs.	Heat BTU gal.	Cost/gal.	Octane no. av.
Natural gas		24,000	1100 cuft	-	-
Propane	4.25	21,680	92,300	12.5	100
Butane	4.80	21,300	102,500	15.0	94
Premium fuel	6.06	20,320	123,200	20.6	92
Regular	6.13	20,280	124,300	18.6	84
Kerosene	6.80	19,000	129,000	-	-
Diesel	7.08	19,590	138,800	16.5	55 cetane
Alchohol	6.80	13,000	88,000	-	-

I. An important engine characteristic that in part determines the type of fuel it can use is its compression ratio. The higher the compression ratio of an engine, the higher octane rated gasoline it must use, because the tendency to knock increases with the compression ratio.

J. Detonation, also commonly known as "knocking" or "pre-ignition" is caused by the explosion of a portion of the fuel. Factors which affect detonation are (1) compression ratio, (2) fuel chemical composition, (3) mixture ratio, (4) mixture temperature, (5) ignition timing, (6) engine temperature, and (7) working conditions (load, speed). Continued operation of an engine that knocks will result in rapid severe wear or damage. Therefore this matter is of serious concern if maximum trouble-free operation is to be obtained.

K. In discussing engine knocking, it is necessary to explain the meanings of octane rating and cetane rating. The octane rating is a means of comparing the antiknock qualities of fuels used in spark-ignition engines with standardized test fuels. Heptane has an octane rating of 0 and iso-octane has an octane rating of 100. These two mixtures are combined to match the performance of a fuel being tested. If a mixture of 10 parts heptane and 90 parts iso-octane matches the performance of the fuel being tested, the fuel has an octane rating of 90. In a spark-ignition engine, knocking is caused by the fuel burning too rapidly. Tetraethyl lead is added to gasolines to control the rate of burning and prevent engine knocking.

1. The antiknock qualities of a diesel fuel are measured by its cetane rating. A similar procedure is followed for determining the cetane rating for diesel fuel as the octane rating is used for gasoline. However, cetane is given a rating of 100 and alpha-methyl napthalene a rating of 0 for a cetane test. A diesel fuel matching antiknock performance with a 40% cetane-60% alpha-methyl napthalene is given a cetane rating of 40. The minimum cetane rating is 35 with an average of about 45. The minimum octane rating is 80 (Motor Method) or 86 (Research Method).

2. In diesel engines, knocking is caused by the fuel igniting too slowly. Therefore the cetane rating measures how fast a diesel fuel will burn when it is injected into an engine cylinder. If the cetane number is too low, the diesel engine may be difficult if not impossible to start; if the engine does start, white puffs of exhaust smoke may appear until the engine warms up.

3. It should be remembered that the antiknock qualities of gasoline and diesel fuel are entirely different. The octane rating indicates how well a gasoline keeps from

pre-igniting while the cetane rating indicates how rapidly and completely the diesel fuel ignites.

L. To avoid engine knock and to give satisfactory performance and fuel economy, a fuel must be matched with an engine having the proper compression ratio. Kerosene and tractor fuel can be mixed satisfactorily in engines with compression ratios ranging from 4.0:1 to 4.7:1. Low grade gasoline can be used in engines with compression ratios in the 5.0-6.0:1 range. Engines with compression ratios of 7.0-8.5:1 require regular gasoline. Premium gasolines are not normally used in tractors. Engines with compression ratios of 9.0-10.5:1 require premium gas for satisfactory operation. Since most gasoline tractor engines are not designed with compression ratios above 8.5:1, there is nothing to be gained by burning premium gasoline in a tractor.

M. A gasoline engine produces work from heated gases which expand when heated to produce power. As the piston moves upward on the compression stroke in a spark-ignition engine the compressed air reaches a temperature of approximately 900°F and 1200-1500°F in a diesel engine. When the spark ignites the air-fuel mixture in a spark ignition engine the temperature reaches about 3500 to 4000°F (similar in the diesel engine) thus driving the piston downward and developing work via the crankshaft. As the burned gases leave the cylinder on the exhaust stroke the temperature is about 1200-1500°F. In this manner, heat energy is converted into mechanical energy in an internal combustion engine.

N. Fuels provide qualities which make them more effective during various seasons of the year. Summer gasolines are developed with low volatility thus preventing excessive evaporation losses in storage (without causing starting difficulty). Winter gasoline is produced with higher volatility, hence, it vaporizes easier and provides for faster starting.

O. In order to provide clean fuel for use in an engine, four factors should be considered: (1) Protection of fuel quality, (2) safety, (3) convenience, (4) cost. Proper storage facilities are essential to reduce evaporation losses of gasoline. Shade, vented caps and a reflective colored paint aid in reducing evaporation losses. In diesel fuel the primary concern is cleanliness. The fuel injection mechanism will cease to function if water or dirt filled fuel is used, hence, diesel storage tanks should be provided with a drain for removal of water and sediment. The primary concern in storing L.P. gas is a safety factor of preventing leaks from developing causing the heavier-than-air gas to accumulate in low spots.

P. Spark plugs have a distinct effect on the horsepower and fuel consumed by an engine. Spark plugs wear out due to the electrical discharge and the heat of the burning gases in the combustion chamber. When purchasing or reconditioning spark plugs it is important to understand the conditions in which the engine operates. Three factors to consider are (1) operating conditions, (2) kind of fuel used, (3) engine design. To meet these conditions manufacturers develop "cold," "normal," or "hot" plugs. The difference in the three types of plugs is the length of the insulator tip. The longer the tip the slower the heat moves out of the plug due to the distance the heat must travel; hence, the longer the tip the hotter the plug. If hot plugs are used when heavy loads are being exerted the plugs will tend to overheat causing engine knock. If cold plugs are used under light loads or idling plugs will tend to foul. Type of fuel may cause a difference in type of plug, with gasoline a hotter plug is needed than with L.P. gas. Design of engine head also affects the length of plug to be used. Too long a plug may interfere with the piston and too short a plug may cause a shielding of the spark and poor ignition.

The following are parts of a spark plug: terminal, porcelain insulator, center electrode, steel shell, seals, copper gasket, insulator nose and ground electrode. Due to higher engine speeds and higher compression ratios, higher voltages have been necessar to insure positive starting and efficient engine operation. Increased voltage is necessary in starting engines by providing more cranking energy.

Q. Compression may be referred to as the squeezing of molecules into a small volume. The greater the compression the greater the thermal efficiency. It is not possible to take full advantage of this in a spark ignition engine because the high pressure may cause early detonation, hence, the diesel engine is somewhat more efficient in operation. Any loss in compression due to wear or damage results in less efficiency.

R. The bore and stroke or the cylinder diameter and the length of travel of the piston and the number of pistons are factors which determine engine size. Generally the stroke is 1.1 to 1.3 times the bore.

S. The power or output of an engine is largely determined by piston displacement and cranksahft speed. The displacement is the volume which the piston travels from top-dead-center to bottom-dead-center.

T. In a four-stroke-cycle engine one port or opening allows fuel and air or air to enter the combustion chamber and another port allows the burned or exhaust gases to leave the combustion chamber. These openings are controlled or blocked by valves. In a two-stroke-cycle engine, the cylinder walls have ports or openings and air is blown into the cylinder and exhaust gases out. Hence, no intake valves are used on this type of engine.

The valve has a flat head with a beveled edge called the face and a stem. The opening in the block or head has a similar edge called the seat. A spring with a wedge and key holds the valve against the seat. The valve stem operates in a sleeve or guide. Exhaust valves operate at high temperatures and are subjected to wear and abuse. Valves are made from steel alloys to resist the wear, heat and corrosion. The stem of the valve is not as hard as the face and the end may be hardened to prevent wear of the rocker arm. Valves, mainly exhaust valves, are allowed to turn or rotate, thus ensuring an evenness of wear. Valves are held shut by a spring action and are opened by rocker arms which are in turn operated by push rods being activated by the camshaft. Valve openings must be timed to correspond with piston position and spark ignition or fuel injection.

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UNIVERSITY

OF

NEBRASKA

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STUDENT WORKSHEETS

ON

PRINCIPLES

IN

AGRICULTURAL MECHANICS

App 2 OES

(Supplement to Publication No. 4)

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT

Department of Agricultural Education
University of Nebraska
In Cooperation With
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

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TO THE STUDENT

The discussion questions in this publication have been developed to supplement the material presented in the publication entitled "Principles In Agricultural Mechanics".

This publication consists of a variety of questions which are designed to briefly summarize the materials presented in each principle area. The questions are of a discussion type, multiple choice, true and false or completion. These questions attempt to emphasize the important points covered in each principle area. Upon completion of the questions, the student should have a rather complete résumé of the information pertaining to agricultural mechanics.

The questions may be answered by writing directly in this publication or by placing answers on additional sheets of paper.

It is recommended that each section of this publication be completed after the entire principle area has been discussed and practical applications have been made by the teacher and students in the classroom and shop.

Assignment
Worksheet No. 1

MEASUREMENTS

Assignment:

1. Review class notes.
2. Review the suggested references.
3. Complete the following questions.

References:

Building Farm Fences, Southern Association of Agricultural Engineers and Vocational Agriculture, Barrow Hall, Athens, Georgia, 1962, pp. 1-33.

Jones, Mack, Shopwork on the Farm, McGraw-Hill Book Company, Inc., New York, New York, 2nd Edition, 1955, pp. 20-136.

Phipps, Lloyd and others, Farm Mechanics Text and Handbook, Interstate Printers and Publishers, Danville, Illinois, 1959, pp. 157-168, 689-706, 761-802.

Questions:

1. Describe the following types of rafters:

   a. Common -

   b. Hip -

   c. Valley -

   d. Jack -

2. What is the purpose of a seat-cut on a rafter?

3. Define the following terms:

Rise -

Run -

Span -

Pitch -

4. Why are studdings and rafters often placed 24 inches-on-center when building a farm building?

5. What may be some adverse effects of stretching wire too tightly?

6. When stapling wire to a wooden post, how should the staple be driven into the post?

7. Describe the procedure to follow in making the corners of a building square.

8. a. How many bushels of ear corn are in a corn crib 8' wide, 24' long and 20' high?

b. How many bushels of shelled corn are in a steel grain bin 16' in diameter and 26' high?

9. Why should wire be placed on the side of a post next to the livestock

10. Why is it important to construct solid corners in a fence?

11. Draw an example of a properly braced corner post. Indicate the correct spacing of all components of a corner.

12. Define the following terms:

Contour -

Watershed -

Ridge terrace -

Channel terrace -

Bench terrace -

Waterway -

13. Describe the procedure to follow in leveling a surveyor's instrument.

14. Describe the procedure to follow in using a surveyor's instrument to level a field.

15. When converting readings taken by a surveyor's instrument, the lowest point or the highest point should have a value of __________.

16. How many squares of wooden shingles, with four and one-half inches exposed to the weather, are necessary to shingle a roof 15 feet wide and 40 feet long? (Show your work)

17. If lumber sold for $160 M, how many board feet would be contained in 8 - 2 x 4 x 16? What would be the cost? (Show your work)

18. How many cubic yards of ready mixed concrete should be ordered to pour a concrete floor 4 inches thick, 20 feet wide and 60 feet long? (No outside footings) What would be the cost if concrete sold for $15.00 per yd.?

19. The two principal parts of a framing square are the ________________ and ________________________.

20. A field that is 10 rods wide and 160 rods long would contain ____________________ acres.

21. List the basic principles discovered in the area of measurements.

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TEACHERS KEY
FOR
STUDENT WORKSHEETS
ON
PRINCIPLES
IN
AGRICULTURAL MECHANICS

(Supplement to Publication No. 4)

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT

Department of Agricultural Education
University of Nebraska
In Cooperation With
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

This publication was prepared in furtherance of a project supported by a grant from the U.S.Department of Health, Education, and Welfare, Office of Education, entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming." The project was initiated by the Department of Agricultural Education of the University of Nebraska, and has been designated DAVR Project No. 001-65, and Contract No. OE-05-85-020.

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TO THE TEACHER

This publication is designed to assist the Vocational Agriculture teacher in checking the answers written by the students in the publication entitled "Student Worksheets On Principles In Agricultural Mechanics."

The purpose of the student worksheets is to provide the student an opportunity to review the material studied in each principle area. The key to teaching agriculture with the principle approach is to allow the students to discover the basic underlying principle. Hence, the student worksheets should not be used until the entire principle area has been completed. After students have discovered the principle and made appropriate applications in agricultural mechanics, the worksheets will provide a review of the principle area. Therefore, the worksheets on each principle area should be given to the student one-at-a-time.

The teacher's key provides the answers for the questions on the student worksheets. The key may be used by the teacher or the student to correct the answers.

Answer Key
Assignment
Worksheet No. 1

MEASUREMENTS

Answers:

1. a. Extends from the plate to the ridge perpendicular to the plate or ridge board.

   b. Extends diagonally from the plate to the ridge at the outside corner of a building to form the hip roof.

   c. Extends diagonally from the plate to the ridge at the line of intersection of two roof sections.

   d. Does not extend from the plate to the ridge.

   Hip jack - Extends from the plate to the hip rafters.

   Valley jack - Extends from the ridge to the valley rafters.

   Cripple jack - Extends from a hip rafter to a valley rafter.

2. The seat cut allows the rafter to rest on the plate.

3. Rise is the vertical distance from the plate to the work or measuring line of rafter.

   $$\text{Rise} = \text{pitch} \times 2 \times \text{run}$$

   Run is the horizontal distance measured from the outside edge of the plate to a point directly below the top end of the rafter.

   Span is the distance from the outside edge of one wall plate to the outside edge of the opposite wall plate. Span = 2 x run

   Pitch refers to the measure of its slope and is defined as the ratio of the rise of the rafter to twice its run or as a fraction having the rise as the numerator and two times the run as the denominator.

   $$\text{Pitch} = \frac{\text{rise}}{2 \times \text{run}}$$

4. They are placed 24 inches on-center because most farm structures do not need to be any stronger than this and lumber is normally purchased in even numbered feet, therefore eliminating sawing off odd ends.

5. If the wire is stretched too tight it will become permanently stretched during the winter and sag the following summer.

6. Slope the staple against the pressure of the wire. Angle the staple downward on level ground and over knolls. Angle the staple upward where the fence runs through a depression. Leave room so the wire can move laterally through the staple because of expansion and contraction.

7. After locating the corner of a building, the following procedure may be used to square the corner. Measure 6 ft. from the corner and mark the location. Then measure 8 feet from the corner along the other side of the building. Then measure the distance between the 6 foot mark and the 8 foot mark. This should be 10 ft. If not adjustments should be made to square the corner.

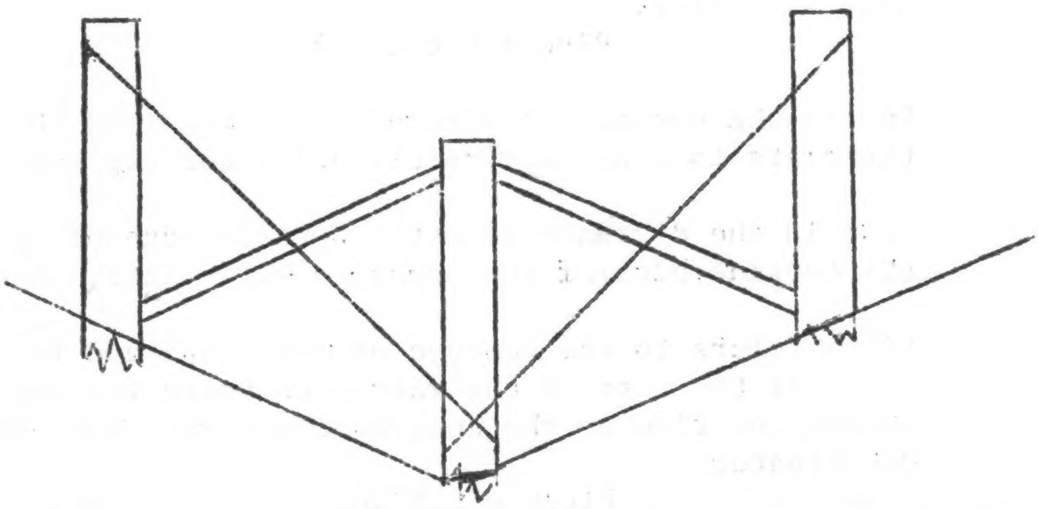
8. a. $V = abc$ 1 bu. ear corn = 2.5 cu. ft.
8' x 24' x 20' = 3,840 cu. ft.
3840 x .4 or 3840 ÷ 2.5 = 1,536 bu. of ear corn

b. $V = \pi r^2 h$ 1 bu. shelled corn = 1.25 cu. ft.
3.14 x 64 x 26 = 5,224.96 cu. ft.
5,224.96 x .8 or 5,224.96 ÷ 1.25 = 4,179.968 or 4,180 bu. of shelled corn

9. The pressure on the wire will be against the post and not only on the staple or fastener.

10. Fence failures often result from corner posts not being well braced and this allows the wire to become loose and sag.

11.



12. Contour - a line passing through points of equal elevation; any line lying wholly on the same horizontal plane.

Watershed - all of an area draining into one watercourse.

Ridge terrace - a terrace built of soil obtained from both sides, its major function is to conserve water. These are best in flat country where not over 30 per cent slope prevails.

Channel terrace - basically shallow diversion ditches which catch runoff water and lead it off to drainageways that have been protected against erosion.

Bench terrace - used in connection with irrigation. Each field constitutes a terrace, separated from the above field and below field by comparatively steep slopes.

Waterway - a diversion or drainage device, usually grassed, which carries excess water to a pond or some other drainage device such as a stream or river.

13. Place the telescope directly over 2 of the 4 adjusting screws. Turn the 2 screws in opposite directions until the level bubble is centered. One screw will loosen or allow one side of the telescope to pivot downward while the other screw will force the remaining end upward. If too much tension is applied to the elevating screw the device will jam. If not enough tension is applied to the descending screw, the telescope will lose contact with the adjustment. After leveling over one set of screws, rotate the telescope 90° in one direction and level it over the other remaining two screws. Repeat the procedure until the instrument is level in all directions.

14. After the level has been set up and prepared for use in the desired location, a distance of approximately 100 yards is measured off with a steel tape or some type of a measuring device. Next the target rod is placed on the 100 yard mark and a reading is taken by the person operating the transit instrument. All readings are recorded on paper. Readings can be taken at varying distances between each other but 10 yard spacings are usually satisfactory. Readings taken in both directions from the instrument will allow a total of 200 yards to be covered from one position.

15. Zero

16. A = 1 w   Shingles are sold by the square and a square is 10 ft. x 10 ft. or 100 sq. ft.
40 ft. x 15 ft. = 600 sq. ft.
600 ÷ 100 = 6 squares of shingles

17. board feet = $\frac{\text{number of pieces x inches thick x inches wide x feet long}}{12}$

$$\frac{8 \times 2 \times 4 \times 16}{12} = 85.3 \text{ board feet}$$

$160 per 1000 board or $.16 per board foot
$.16 x 85.3 = $13.75

18. V = abc 1 cu. yd. = 27 cu. ft.
20' x 60' x 1/3' = 400 cu. ft.
400 ÷ 27 = 14.8 cu. yd. or 15 cu. yd.
15 x 15 = $225.00

19. The two principal parts of a framing square are the tongue (usually 1½" x 16") and the blade 2" x 24".

20. 160 sq. rds. = 1 acre A = 1 w
160 x 10 = 1600 sq. rods
1600 ÷ 160 = 10 acres

21. a. When the opposite sides of an area, bounded by four sides, are equal, the four corners will form 90° angles with opposite sides parallel, if the diagonals are equal.

b. The square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides.

c. The volume of some regular shaped objects equals length times width times height.

d. The volume of a right circular cylinder equals πr^2 times the height and the volume of a cone equals $1/3\, \pi r^2$ times the height.

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OF
NEBRASKA

PRINCIPLES
IN
AGRICULTURAL
MARKETING
AND
MANAGEMENT

Roland L. Peterson
and
James T. Horner

Publication No. 10 - 1967

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
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PREFACE

Farming and other agricultural businesses are important aspects of the American economy. The area of marketing and management of agricultural resources has become vitally important to the success of the businesses. Technical "know how" in the operation of an agricultural business for maximum profits includes the management aspects of the operation, plus management decisions of agriculturists are of utmost importance.

This handbook was written for the purpose of providing a basic outline to help teachers of agriculture teach farm management in an effective manner. A basic group of marketing and management principles was selected in an attempt to develop economic and management subject matter around this core of basic principles. The "principles approach" lends itself well to the subject matter due to the fact that basic economic principles have practical applications in the operation of a farm business or any other agricultural business. Thus, economic education has practical everyday effects on agricultural decision making.

Each principle unit in this publication is based upon an important economic principle that has applications to agriculture. Other economic principles were omitted because it was felt they were partially covered in this material or they did not have major applications to agriculture.

Professor Sidney S. Sutherland, University of California, Davis, California and Dr. Floyd McCormick, Ohio State University, Columbus, Ohio have made initial efforts in material development in the area of management principles. However, a review of the materials revealed that inductive discovery of underlined principles was not used in the manner proposed in this publication. Also, a problem of terminology exists.

Credit is due the following men who provided materials in the development of this publication:

Dr. A. W. Epp - Department of Agricultural Economics, University of Nebraska.
Professor James Greer - Department of Agricultural Economics, University of Nebraska.
Dr. Glen Vollmar - Department of Agricultural Economics, University of Nebraska.

Recognition is also due Dr. John D. Coster for his helpful suggestions in the beginning stages of the development of the materials.

Special recognition is due Professor U. E. Wendorff for his supervision and development of some of the lesson outlines used in this publication.

The material was taught by the following teachers in Nebraska during the 1967-68 school year:

Teachers	School
James Osborn	Arnold
Irving Wedeking	Aurora
Larry Schrick	Blue Hill
Alton Crook	Clarkson
Edward Stich	East Butler
Stanley Elsen	Perkins County (Grant)
Jess Vetter, Jr.	Hemingford
Robert Kelly	Howells
Don Tapley	Hyannis
Sidney Borcher	Newman Grove
Leon Deunk	George Norris
Donald Blecha	Osmond
James Boyle	Superior
Donavon Benson	Syracuse
Ted Ward	Verdigre

Mr. Darrell Siekman, Mr. Dale Zikmund and Mr. Douglas Genereux, graduate assistants deserve considerable credit for their efforts in helping develop and review materials for this publication.

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INTRODUCTION

The material in this publication may be taught in a variety of ways. A method of teaching to provide teachers with a guide is suggested.

In teaching the material presented in this publication -- some overlapping between principle areas is very likely to occur. This problem is due to the fact that many of the understandings are very closely related to each other. For example the principles of diminishing returns, opportunity costs, substitution,combination of enterprises and comparative advantages all have many common elements. The principle area of production is an attempt to summarize all of the principles and hence is a combination of several areas. It is an attempt to put all the resources together. It is suggested that teachers add to the principle areas as they see fit and the teaching materials are not intended to be entirely complete. The order or sequence of presenting the principles in this publication is not meant to imply they must be taught in this manner. If another arrangement makes teaching easier they may be taught in a number of orders.

The material presented in each principle unit is categorized as follows: (1) Principle, (2) Objectives, (3) Application to Agriculture, (4) Demonstrations, Experiments, Problems, (5) Definitions and Facts, and (6) References. It is suggested that an inductive approach be used to introduce the principle unit of instruction. The key to inductive teaching is the withholding of any statement of the principle until the students have had an opportunity to observe, study and consider several instances in which the principle is involved. The teacher should provide instances for discovery of the principle through the use of demonstrations, experiments or problems suggested and presented by the teacher or by field observation. Before introducing each demonstration, experiment, or problem the students should be asked "What will happen?" and "Why does this occur?" The answer to these questions will eventually lead students to the discovery of the underlying principles. Hence, students have been led inductively from the observed or demonstrated situation to the cause or causes of the situation. At this point deductive approach should be used to take the students from the known situations to its applications to agriculture through the use of problem solving.

The above procedure may be illustrated by using the principle unit of pricing as follows: The teacher begins the unit by having the class participate in experiment "B" of the "Demonstrations, Experiments, and Problems" section of the principle unit. After the teacher has conducted a game with the students, the students should be led to discover the principle of pricing. Students observe the principle in operation every day but this situation presented in class should cause them to ask and give reasons "why" prices are established at certain levels. After students have discovered the principle, it is an easy step to reveal the laws of supply and demand: supply "The higher the price which prevails, the more of a product will ordinarily be placed on the market, the lower the price the less of a product will be offered for sale"; demand "If other things remain the same, the higher the price, the fewer the units taken; the lower the price, the more units taken. on the basis of this discovery students may be directed to apply the principle to specific agricultural marketing problems.

The following procedure is suggested for teaching a class using the "princples appraoch":

Steps	Key Points
1. Withhold and statement concerning the principle.	1.1 Teach inductively. 1.2 Allow students to discover the underlying reason for a principle.
2. Introduce the principles by having students observe or experiment with known situations and/or problems.	2.1 Recall situations in production agriculture in regard to the principle. 2.2 Teacher and/or students conduct experiments. 2.3 Teacher conducts a demonstration. 2.4 Teacher presents problems.
3. Reveal the principle.	3.1 Draw conclusions from the students that each demonstration has something similar. 3.2 Summarize the obervations by stating the principle. 3.3 Give students the definition of the principle.

4. Teach the facts and definitions regarding the principle.	4.1 The facts give the students background about the principle. 4.2 Facts and definitions will aid in a further understanding of the principle. 4.3 Facts and definitions should be mimeographed presented as a handout to the students. 4.4 A small or large group discussion technique may also be used in presenting the facts and definitions section.
5. Apply the principle to agriculture.	5.1 Teach the problems which relate to production and off-farm agriculture. 5.2 Provide shop, laboratory, classroom or field trip observation situations in presenting the knowledge and skill needed by students in relation to the principle. 5.3 Use visuals or any type of learning resource media or material to effectively provide students with the agricultural knowledge and skill. 5.4 The problem-solving method of teaching is an effective method of making the applications to agriculture.
6. Provide students with worksheets for review and individualized study.	6.1 After the applications have been completed allow students to complete the worksheets for each principle. 6.2 Check the answers with the teacher's key.

TERMINOLOGY

The question may be asked, "What is a principle and how do principles differ from a concept, a rule or a fact?" According to Sutherland and Sams,

> "A principle is a fundamental truth, a law of conduct that has general applications and is a basis for action. It is a generalization based on facts and on elements of "likeness" common to a number of situations. Since a principle is a generalization, there are sometimes minor exceptions to it, but it still has general application.[1]

Following is a comparison of a principle with a rule, a fact, a concept, or a law.

A rule is a specific direction or regulation for action, and generally is based upon a principle or principles.

A fact simply states something that actually exists or has been done.

A concept is a generalization made by an individual. It is an idea, a mental image based upon an understanding of all that is associated with or suggested by a term.

A law is a generalization that, so far as is known, is invariable under given conditions.[2]

---

[1] Sutherland, Sidney S. and W. Earl Sams, Biological Principles in Agriculture, California State Department of Education, and University of California, Davis, California, 1963. p. 2.

[2] Ibid., pp. 2-3.

PRICING

I. PRINCIPLE:

A. Supply
The higher the price which prevails, the more of a product will ordinarily be offered for sale, the lower the price, the less of a product will be offered for sale.

B. Demand
If other things remain the same, the higher the price, the fewer the units taken; the lower the price, the more units taken.

C. The relationship between the quantity of a product supplied and the amount demanded by consumers determines the price of the product.

II. OBJECTIVES:

A. To learn the processes involved in establishing a price for an agricultural commodity.

B. To learn the various methods of marketing.

C. To learn the function of various marketing agencies and what is their marketing margin.

D. To learn the role of agriculture in the pricing system of a capitalistic economy.

III. APPLICATIONS TO AGRICULTURE:

Problems or Topics

A. What factors control market prices?

1. Discuss the problem in the classroom and consider the following:

Livestock
a. Size
b. Age
c. Sex
d. Consumer likes or dislikes
e. Season of year
f. Processing
g. Quantity produced
h. Consumer income
i. Quality
j. Degree of finish

Crops
- a. Consumer preferences
- b. Grade or quality of grain (color, nutritional content, cleanliness)
- c. Quantity produced (weather)
- d. Moisture content

B. What are the functions of marketing agencies?

1. Discuss the problem in the classroom and consider the following:

- a. Assembling
- b. Grading
- c. Packaging
- d. Transporting
- e. Processing
- f. Distribution and advertising
  - --Wholesaling
  - --Retailing
- g. Financing
- h. Storage

2. Compare the above possible functions to the following factors:

- a. Costs
- b. Labor
- c. Time
- d. Mark-up
- e. Risk-bearing

C. What factors are involved in market trends?

1. Discuss the problem in the classroom and consider the following factors.

- a. Seasonal trends
- b. Cyclic trends
- c. Consumer change
- d. Technological changes
- e. Specialization

D. What procedure should we follow in marketing livestock at a terminal market?

1. Discuss the problem in the classroom. May consider a field trip to the market.

Steps	Key Points
1. Assemble livestock	1.1 Hire trucker

	1.2 Fill properly.
	1.3 Load carefully.
2. Transport livestock.	2.1 Drive cautiously - avoid sudden stops.
	2.2 Provide protection during extreme weather conditions.
3. Consign to commission firm.	3.1 Inform when unloading.
	3.2 Establish a relationship with a reputable firm.
4. Transact sale of livestock.	4.1 Allow commission firm to display livestock.
	4.2 Obtain several bids.
	4.3 Accept the most favorable price offer.
5. Complete final settlement.	5.1 Obtain final check.
	5.2 Pay commission, yardage and trucking fees.

F. What procedure should we follow in marketing livestock directly to the packing company?

1. Discuss the problem in the classroom. May consider a field trip to the market or a meat packing company.

Steps	Key Points
1. Negiotiate a price.	1.1 Buyer bids on livestock in the feedlot.
	1.2 Farmer accepts or rejects the bid.
2. Assemble livestock.	2.1 Hire trucker.
	2.2 Fill properly.
	2.3 Load carefully.
3. Transport livestock.	3.1 Drive cautiously. Avoid sudden stops.
	3.2 Provide protection during extreme weather conditions.
	3.3 Livestock are usually expected at the packing plant at a specific time.
4. Transact the sale of livestock.	4.1 Weigh the livestock.
	4.2 Accept the price.

5. Complete final settlement.	5.1 Obtain final check. 5.2 Pay trucking costs.

G. Should we sell our livestock on the grade and yield basis?

1. Discuss the problem in the classroom and consider the following:

Advantages	Disadvantages
1. More accurate pricing	1. Free competitive bidding is destroyed as the price is not established until the animals are slaughtered. (Difficult to move 100 carcasses to another packer if dissatisfied with price.)
2. Fill would no longer be a factor and a farmer would not be discriminated against or because of fill.	2. Hogs can be estimated about as accurately on the hoof as they can when slaughtered, hence, of little value as graders still must judge the carcass.
3. Bruised animals would be easily identified to a farmer and only he could be penalized rather than all producers.	
4. Farmers would be paid for producing the strictly meat-type hogs. Presently there is a relatively small premium for raising meat-type hogs.	
5. Consumer preferences may be reflected in the marketing system in a more prounounced manner.	

H. What procedure should we follow in marketing grain?

1. Discuss the problem in the classroom and consider the following procedure. May consider a field trip to local elevator or grain terminal.

Steps	Key Points
1. Load the grain.	1.1 Directly in field. 1.2 From a storage facility. 1.3 Dry if necessary for improved price.
2. Haul to a market.	2.1 Protect from moisture.
3. Transact the sale.	3.1 Weigh the grain. 3.2 Obtain a sample for price determination. 3.3 Negotiate the price between elevator and farmer.
4. Complete the final settlement.	4.1 Pay trucking costs. 4.2 Obtain final check.

I. What factors are considered in determining the market price of grain?

1. Discuss the problem in the classroom and consider the following factors for all types of grain.

   a. Moisture content
   b. Weight per bushel
   c. Purity
   d. Color
   e. Freedom from disease and insect damage
   f. Mechanical damage
   g.

J. Should we sell our livestock directly to the processor? Or should we sell to the terminal market?

1. Discuss the problem in the classroom and consider the following:

Direct - Why	Why Not
1. Less marketing cost.	1. Little competition in bidding for the livestock.
2. Transportation costs may be less.	2. Professional commission firm may be able to get more money for livestock.
3. Can be guaranteed a price before leaving home.	3. Not certain received highest price.

4. Less time consuming.

5. Can sell on grade and yield basis.

Terminal - Why	Why Not
1. More competition.	1. Costly.
2. Professional commission firm should sell for a farmers advantage.	2. No guarantee on price.
	3. Time consuming.
3. Higher price.	4. Not certain received highest price.

K. Should farmers withhold livestock and crops from the market?

1. Discuss the problem in the classroom and consider the following:

Yes	No
1. May force price up.	1. Costly to hold livestock that are ready for market.
2. May be able to withhold for a few days if price is fluctuating.	2. Inefficient use of feed.
	3. Put an inferior quality product on the market.
	4. Extremely difficult to sell on the day prices were at top.
	5. Long storage periods result in low quality grain.
	6. Withholding may drive price up during withholding period but when finally put on market it will drive price down.

Conclusion: Preplanning of livestock and crop production with concern and emphasis on supply control may be the most effective means of improving prices.

L. What factors should we consider in determining when to market crops and livestock?

1. Discuss the problem in the classroom and consider the following:

a. Consumer preferences
b. Desired market weights
c. Labor demands - field work, etc.
d. Housing and storage facilities
e. Feed supply
f. Feed prices
g. Weather conditions
h. "Futures" prices
i. Daily market price
j. Day of the week
k. General economic trends

2. Compare the above factors to various crops and livestock.

M. What factors are considered in determining the grades of grain?

1. Discuss the problem in the classroom and consider the following:

a. Weight per bushel
b. Moisture content
c. Color
d. Shriveled kernels
e. Disease
f. Mechanical damage
g. Protein content

2. Compare the above factors to the following grades.

a. No. 1
b. No. 2
c. No. 3

N. What factors are considered in determining the grades of livestock?

1. Discuss the problem in the classroom and consider the following:

a. Weight
b. Backfat thickness
c. Sex
d. Finish
e. Loin eye size
f. Length of carcass
g. Meatiness
h. Firmness

2. Compare the above factors to the following grades of each kind of livestock.

   Hogs:
     No. 1, No. 2, No. 3, Medium, Cull
   Beef:
     Prime, Choice, good, standard, commercial, utility, canner, cutter
   Sheep:
     Prime, choice, good, utility, cull
   Poultry:
     A Quality, B Quality, C Quality

O. Should a farmer consider hedging on grain and beef?

   1. Discuss the problem in the classroom and consider the following:

Advantages	Disadvantages
1. Minimize losses by buying a future.	1. Lack of understanding futures market.
2. Avoid violent price changes.	2. Brokerage costs when dealing in futures.
3. Avoid spoilage or low quality product.	
4. May increase prices.	
5. Year-around market avoids abrupt price changes.	
6. Insurance against adverse price changes.	

P. Should we (the farmer) store grain on the farm or in an elevator?

   1. Discuss the problem in the classroom and consider the following:

Farm Storage

Advantages	Disadvantages
1. Earn storage income (Increase price and storage payment if sealed)	1. May need additional insurance.

2. May speed up harvest time.	2. May need to fumigate and aerate the grain.
3. May utilize farm labor more effectively.	3. May need to provide an additional building.
	4. May need to repair building.
	5. Extra handling costs may be involved.

Elevator Storage

Advantages	Disadvantages
1. No risk to producer in loss due to quality deterioration or due to quantity.	1. Loss of storage income (both price increase and storage payment if sealed)
2. Storage facilities maybe better (less grain contamination or loss)	2. Slows harvest time hauling and waiting to unload.
3. Pay only for space used.	3. Labor may have to wait while unloading occurs.
4. May eliminate some extra handling costs.	

Conclusion:

IV. DEMONSTRATIONS, EXPERIMENTS, PROBLEMS:

A. Provide two students in the class with one package of gum each. Tell one student to offer each stick for sale at 2 cents each. Tell the other student to sell his gum at 10 cents each. Who sold out first? Why? (One student experienced a greater quantity demanded because he was asking a more favorable price.)

B. Provide five students in the class each with five half pints of white milk. (Depending on size of class--be sure you have at least 2 pints per student). Charge each student 5 cents for each half pint. Inform students that they may sell the milk to their fellow students at whatever price they may desire - except they must at least cover their costs. Determine the average selling price after the sales have been completed. Who sold out first? Why? What reason kept price down? What reason kept price up? What return did the students get on their investment? Was any milk left? How was surplus milk sold? Why was price at a certain level? Why not higher? Why not lower? What determined the market price? (If other things remain the same generally, the higher the price, the fewer the units taken; the lower the price, the more units taken).

C. As the teacher, offer to buy milkweed pods for ½ cent each in lots of 10. Make the announcement in class. How many were purchased the next day? Now announce that you'll purchase pods at the rate of 10 cents each. How many were purchased the next day? Why did you buy few one day and many the second day? (May wish to use play money the second day.) The higher the price, the more of a product will be forthcoming; the lower the price, the less of a product will be offered for sale.)

D. Provide three students with $20,000.00 worth of paper money and they must spend it all. Provide the remainder of the class with various acreages of wheat and they must sell all but enough for seed. Inform the students with wheat for sale that it cost each of them $40.00 per acre to produce the wheat. Determine the selling price? Was any wheat left over? Why? Why was the price at this level? Now place a support price on wheat slightly higher than the established market price. Restrict acreages to the same as the previous year. Inform the three buyers they must spend the entire $20,000 (if they can); however, they cannot spend over $.30 a bushel to break even. How much wheat did the three buyers purchase? How much did the government purchase? Where was the price level? Why?

Have students develop reasons why price levels were determined in each situation? What is the basic underlying reason? (Again, the higher the price, the more product people are willing to sell; the lower the price, the less of a product will be offered for sale.)

V. DEFINITIONS AND FACTS:

Elasticity - is referred to as the responsiveness of consumers and suppliers to a change in the price of a product.

Inelasticity - is referred as the resistance or slowness of consumers and suppliers reaction to change in the price of a product.

Elastic demand - refers to the demand for a product by consumers in relation to price changes. If price changes cause a rapid change in the quantity purchased by consumers, the demand for the product is said to be elastic. If price changes cause relatively small changes in the quantity purchased by consumers, the demand for the product is said to be inelastic.

Elastic supply - refers to the changes in production in response to price changes. If rapid changes occur in production, as prices change, the supply is referred to as elastic. If little change occurs in production as a result of a price change, the supply is referred to as inelastic.

-Thus when a large change in price results in a small change in quantity demanded this situation refers to a product with an inelastic demand, and if a small change in price causes a large change in quantity demanded the product has an elastic demand.[1]

Agricultural products generally have an inelastic demand and supply because change in price results in (1) a small change in demand, and (2) in the short run supply changes very little. In the long run, the supply and demand for agricultural products may tend to be more elastic.

Very short run - refers to the fact that all resources are fixed and no changes can take place. An example may be a farmer marketing a box of strawberries; if they are not sold within the day they perish and are of little value. Thus, the farmer must accept the price and is not able to change anything.

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[1] Campbell, R. McConnell, Elementary Economics: Principles, Problems, and Policies, McGraw-Hill Book Co. Inc., New York, 1960, pp. 401-402.

Short run - refers to the fact that some resources are fixed but some are also variable. An example may be a farmer with a beef enterprise who may be able to increase his capacity by enlarging the size of feed yard. This expansion may be done within a few days. Thus, the land resource was changed quickly.

Long run - refers to the fact that all resources are variable and everything can be changed. An example may be that a farmer may find the beef finishing enterprise unprofitable and changes the buildings, feed grains, other feed supplies to a swine finishing enterprise which is more profitable.

Hedging and Speculation - hedging is made possible through purchase and sale of contracts. These contracts call for delivery of a commodity at a future day agreed to by buyers and sellers. The owners of futures contracts have a claim against a physical inventory of grain or beef to be delivered at a specified date. Hedging is a form of insurance and protects the owner against the risk of a price change. If a person buys grain on the cash market, he may sell a futures contract against it, thus, insuring himself a particular price. If he sells grain on the cash market, he may buy a futures contract against it, thus, he insures himself a particular price. If he sells grain on the cash market, he may buy a futures contract against it, thus, he insures himself against price changes. The following example may illustrate the function of a hedge:

> On July 15 a grain elevator purchases 5,000 bushels of wheat from several farmers for $2.00 per bushel. This cost the elevator $10,000.00. Since cash prices are fluctuating, the elevator manager is concerned about losing money on the grain purchased so he calls a broker and sells 5,000 bushels of wheat on the futures market for $2.[illegible] Thus, he agrees to sell the wheat for future delivery for $10,500.00. Now on August 1, his 5,000 bushels of wheat arrive at the terminal market and is ready for a cash sale. The price has now declined and the wheat is sold for $1.90 per bushel. Thus, on the cash market, the local grain elevator lost $1,000.00. He again looks over the futures market and buys 5,000 bushels of wheat at $2.00 per bushel for $10,000.00. As he analyzes his cost and sales, he finds:

	Cash Market	Futures Market
July 15	Buy $10,000 grain	Sell $10,500
Aug. 1	Sell $9,500 grain	Buy $10,000
	Lost $500.	Made $500.

Thus, despite the drop in the cash market price he broke even. Without his use of the hedge, he could have lost $500.00 by only using the cash market. Although the futures market became only a paper transaction for him, it prevented a $500.00 loss. Thus, futures markets tend to stabilize the marketing process. Without this option, the elevator manager may have paid a lower cash price to the farmer to insure at least a break even price for himself.

Futures Markets

The futures market has two types of dealers, the speculator and the hedger. Speculators hold no physical inventory of a commodity but expect to profit by price increases or decreases if their predictions are correct. Hedgers hold or desire to hold a physical inventory for which he can be assured of purchasing or selling at a certain price. A speculator stands to lose or profit on the basis of his judgement about prices which will be established in the future. A hedger protects a present inventory or a future inventory against adverse price increases or price decreases. Consequently he usually does not make a killing nor does he suffer a severe loss from price variations. He is minimizing the risk of price variations while holding inventories. The futures system succeeds in shifting risks of price variation from people not in a position to speculate (the hedgers) to people who wish to speculate. Cash and futures prices usually become nearly equal in the month of delivery at the market where the futures contract was established. The following is an example of a common relationship between cash and futures prices for wheat.

During these months, the cash price of wheat usually increases. This is the normal seasonal price trend between July and December.

Some costs incurred while trading on the futures market are:

1. Interest on the margin deposit. A margin is the deposit of funds by the customer to guarantee performance on contracts. The margin on wheat on Sept. 1, 1967 was 15¢ per bushel. At an interest rate of 7 percent, the interest on the margin is 1.05 cents per bushel.

2. Brokerage fees - a service charge for handling transactions. The fee is $22. for a 5,000 bushel lot traded and covers both the in and out transactions. This is 0.44 cents per bushel.

Farmers use the futures market:

1. To fix the price of the crop or livestock before harvest or feeding and delivery.

2. To fix the price of grain in storage for later delivery.

3. To fix the cost of feed without taking immediate delivery. Here, we shall discuss only the first two uses since they are the primary ones adaptable to wheat enterprises.

Example 1. Fix the price of the crop ahead of time. By selling July futures before planting or during the growing season, Nebraska farmers can assure themselves within fairly narrow limits a net price they will receive if they sell the wheat at harvest.

Presume that a farmer at Sidney, Nebraska on Sept. 1, 1967 is interested in determining what net price he can set for wheat harvested and sold on July 1, 1968 if he uses the futures market to hedge. On Sept. 1, 1967 the July wheat futures at Kansas City was $1.57 per bushel. This is not the price he can guarantee himself at harvest. There is a large difference in wheat prices between the terminal market at Kansas City and the local elevators at Sidney, Nebraska. This large price difference is due, primarily, to transportation costs from Sidney, Nebraska to Kansas City. It is usually about

25 cents per bushel. The approximate net price he could guarantee himself July 1, 1968 is:

$1.57	The Kansas City July futures price on Sept. 1, 1968.
- .25	The transportation differential between Sidney and Kansas City.
- .010	The interest on the margin.
- .005	The approximate brokerage fee.
$1.305	Net price at Sidney on July 1, 1968 by hedging on Sept. 1, 1967.

The $1.305 per bushel should be close to the actual net price realized on July 1, 1968 if the farmer hedges. This is possible because the ½ price of the July futures when the farmer makes the offsetting contract should be equal to the Kansas City cash price on July 1 which should be about 25 cents higher than the price at Sidney on July 1.

The following cash and futures transactions must be made in order to net $1.305 at Sidney on July 1.

Futures and Cash Transactions

Date	Cash	Futures
Sept. 1, 1967		Sells 5,000 bushels July wheat @ $1.57.
July 1, 1968	Sells 5,000 bushels cash wheat @ $1.20.	Buys back 5,000 bushels July futures @ $1.47.
		Gain on the futures transaction = 10¢ per bu.
	$1.20 price at Sidney .10 the loss on the futures transaction $1.30 net price at harvest by hedging	

If the price of wheat is only $1.20 per bushel at Sidney on July 1, 1968, then it pays for the farmer to hedge. If the price of wheat at Sidney is $1.40

on July 1, 1968, then it will not have paid the farmer to hedge on Sept. 1, 1967 for a price of $1.305 per bushel. See the following transactions.

Futures and Cash Transactions

Date	Cash	Futures
Sept. 1, 1967		Sells 5,000 bushels July wheat @ $1.57.
July 1, 1968	Sells 5,000 bushels cash wheat @ $1.40.	Buys back 5,000 bushels July futures @ $1.67.
		Loss on the futures transaction = 10¢ per bu.
	$1.40 price at Sidney	
	- .10 the loss of the futures transaction	
	$1.30 net price at harvest by hedging	

In this example, the cash price realized was higher than the price at which the farmer hedged. Although he receives the $1.40 per bushel cash price, he lost $.10 per bushel on the futures transactions.

These sample transactions show how a farmer who accounts (1) transportation differentials between his local market and the terminal market where the futures market is located (2) the brokerage charges on futures transactions, and (3) the interest on the margin can assure himself of a price prior to delivering the crop. These transactions also show that a farmer only protects himself against a lower cash price than the price he hedges for. That is, if the cash price is lower than the hedged price, the farmer has gained by hedging. However, if the cash price is the same or higher than the hedged price, the farmer foregoes the higher cash price since the transaction in the futures market is a loss; the loss on the futures transaction should just equal the difference between the cash price realized and the hedged price.

Example 2. Fixing the Price in Storage for Later Delivery. The decision to accept the forward price by hedging the grain inventory is speculative. Again, hedging protects only against a decline in price. If the cash price rises above the hedged price, the gain in cash price is foregone.
Sometimes, the futures market can be used to assure a profit on grain in storage. However, to do this, a storer of grain has to know accurately his storage costs from the time of the hedge to the time of delivery and the price differential between the local market and the terminal market where the futures market is located.

Some local grain elevators use the futures market in just this manner to assure not taking a loss on grain in storage. The transactions are like those already shown.

Another example using slightly different prices shows what will happen when cash prices decrease or increase.

Elevator operator buys wheat January 1. Wants to guarantee price June 1 using Kansas City Future.

	Cash		Futures
Jan. 1	Buy 5000 bu. $1.30	Sell	Future 5000 bu. at 1.64
June 1	Sell 5000 bu. $1.20	Buy	Future 5000 bu. at 1.54
	Lost $500.		Gain $500.

Jan. 1	Buy	$1.30	Sell		$1.61
June 1	Sell	1.40	Buy		1.74
	Gain	$500.		Lost	$500.

The Grain Terminal Market

The terminal market is a place where the processor meets the producer or his representative and together they determine the price of a commodity. The large grain terminal provides a farmer with a market for his grain whenever he wants to sell it. At the terminal, someone is always wanting to buy and someone is always willing to sell grain. The competition is very keen and this results in competitive prices to the farmer and the processor or consumer. An organization known as the Grain Exchange provides the meeting place (buildings, equipment and facilities) for buyers and sellers, gathers information pertinent to grain marketing and provides other services needed for efficient grain marketing. It does not buy or sell grain itself but provides services and facilities. All of the members of the exchange buy and sell grain, but, the exchange does not. It does not set grain prices, only records the price after a buyer and seller have agreed on a transaction. The Grain Exchange provides a place for two markets, namely, the cash market where a buyer purchases a commodity and it is delivered immediately, and, the futures market where purchases made on a commodity may be delivered several months later. In the cash market, commission firms rent tables to display samples of grain offered for sale. The sample contains a portion of the grain and a card which lists the official grade, test weight, moisture content, point of origin, etc. Buyers representing processors, terminal elevators, exporters, and merchandisers inspect the samples and bid on the grain. The grain is sold to the highest bidder and the commission firm deducts its commission from the total sale, plus transportation and other costs and remits to the seller. The grain is usually delivered to the buyer within 10 to 30 days. In the futures market the operation is somewhat different than the cash market. No grain samples are needed since contracts for future delivery are sold on a grade only basis. Under the futures arrangement, the seller agrees to deliver a specified amount and grade of grain during a certain month, and the buyer agrees to pay a certain price for a certain kind, quantity, and grade of grain. Trading in the futures market is usually made in units of 5,000 bushels, which is referred to as a "round lot". Smaller units of 1,000 bushels are referred to as "job lots" and sometimes used. When a trade is made the buyer and seller each deposit money which guarantees that both will live up to the contract. The real value of the futures market is (1) it helps the process of distribution by leveling out the supply, (2) allows for hedging which is an insurance against loss through fluctuating prices. Thus, the terminal market provides a market for grain and with both the cash and futures market, a great deal of stability is available in the grain marketing business.

The Livestock Terminal Market

The terminal market provides an opportunity for sellers of livestock to meet with buyers of livestock. The terminal market consists of the (1) stockyard company which owns the land, yards and equipment (scales, etc.) and employees people to unload, feed, water, count and place livestock in pens. It receives income from yardage fees, feed sales, bedding sales, office rental space and rental from buildings on the land. It neither buys nor sells livestock. (2) The commission companies primary function is to sell livestock consigned to them and to purchase stocker and feeder cattle by order for farmers. They charge a commission or fee for their services. They are skilled salesmen and attempt to obtain the highest possible price for the livestock. They deduct charges for yardage, feed, commission and transportation and send the remainder of the sale to the consigner, (3) Buyers provide the market with the outlet for the product. There are several types of buyers on a terminal livestock market; namely (a) packer buyers - who are employed by most processing plants, (b) order buyers - who are individuals or partnerships that purchase livestock for distant processors or others. Order buyers charge a commission for their service and generally are buying for specific orders; thus, order buyers can give a market a reputation for certain types of livestock (size, sex, weight, etc.), (c) the third type of buyer is often referred to as traders, scalpers, dealers, or speculators. They purchase livestock from commission firms and hope to make a profit by pooling several small lots together or just offering it for sale within the next few days. They often purchase animals which need additional feeding and have feedlots close to the market where these animals may be finished. (4) The Livestock Exchange is an organization of commission firms and may include traders, packer buyers and order buyers. The primary purpose of the Livestock Exchange is (1) to assure fair dealings between the members of the exchange and (2) to promote interest in the terminal market. They set commission charges (subject to the Secretary of Agriculture approval), require members to post bonds for financial responsibility, and deal with other problems of common concern around the yards. (5) Other agencies providing services are banks (aid buyers to make prompt payments and loan to farmers and feeders), and market news agencies (report market transactions and promote the livestock market.) The federal government provides several functions on the market in maintaining reporting standards, fair marketing practices, health inspections, and meat inspections. Thus, the terminal market holds an important place in marketing livestock.

Other livestock marketing methods include (1) Direct marketing, this method of marketing provides the livestock producer with a direct sale to the processor. A trend today appears to be toward increased use of the direct market procedure. Packing companies are moving some of their plants to the livestock producing areas. As a result, it is not uncommon for a producer to have several bids on his livestock in the feedlot. Thus, some of the competition of the terminal market is provided. There are several advantages and disadvantages which will be discussed in the application to agriculture section. (2) Local livestock auctions also provide a market outlet for livestock. Again a properly managed business can earn a favorable reputation by the quality of livestock offered for sale and the competitive bidding of buyers. Local auctions often provide an excellent market for purchase of feeder livestock. (3) The selling of animals on a grade and yield basis is also a method of marketing used by a number of packing companies. Some countries (Canada and Denmark) use a grade and yield method of marketing almost exclusively. One of the primary concerns of most livestock producers is the matter of fair and accurate prices. The on-the-hoof method presently used often leaves producers and buyers with a feeling of incorrect pricing. The grade and yield method is one attempt to improve the accuracy of pricing. With the grade and yield method some base price is sometimes agreed upon and then the price is adjusted as the carcass is evaluated by a professional grader. The chief disadvantage is that if the producer is not satisfied with the price there is little he can do about it as the carcasses are most difficult to move to another packing house. The advantages of grade and yield are generally as follows: (a) prices are generally closer to the true market value,

(b) fill is no longer as crucial a factor as price is determined by the quality of the carcass grade and the dressing percentage, (c) bruises and diseases could be easily traced to particular farmers and hence every producer would not be penalized, (d) premiums could be paid for high quality, meat-type animals whereas the present system frequently does not provide a price differential for meat-type animals. (4) The "sale by head" is generally the least accurate method of selling livestock. The buyer must estimate weights in this case and must be conservative to prevent excessive pricing. (5) The sale on a "weight basis" is a more accurate price estimation than the "by head" method. The chief disadvantage seems to be that little emphasis is placed on quality (although some packing companies attempt to apply a method). Animals of high quality tend to be valued the same as low quality and an appropriate differential is not made. Too often the scale determines the price.

In both grain and livestock marketing, several factors are involved in determining if the local auction, or elevator interior packer, or terminal market is the most profitable marketing method. Such factors as time, transportation, grade and quality of product, competition, size of lot being sold, all must be considered in determining the most profitable procedure.

The following are grades of market livestock:

Beef	Veal	Lamb	Pork	Poultry
Prime	Prime	Prime	U.S.No. 1	A Quality
Choice	Choice	Choice	U.S.No. 2	B Quality
Good	Good	Good	U.S.No. 3	C Quality
Standard	Standard	Utility	Medium	Rejects
Commercial	Utility	Cull	Cull	
Utility	Cull			
Cutter				
Canner				

The following are the grades for corn, oats and hard red winter wheat:

CORN

Grade	Minimum Test Weight Per Bushel	Moisture	Cracked Corn and Foreign Material	Damaged Kernels	
				Total	Heat
	Pounds	Percent	Percent	Percent	Percent
1	56	14.0	2	3	0.1
2	54	15.5	3	5	0.2
3	52	17.5	4	7	0.5
4	49	20.0	5	10	1.0
5	46	23.0	7	15	3.0

SAMPLE = sample grade shall be corn which does not meet the requirements for any of the grades **from** No. 1 to No. 5 inclusive; or which contains stones; or which is musty, or sour, or heating; or which has any commercially objectionable foreign odor; or which is otherwise of distinctly low quality.

OATS

Grade	Minimum Limits of		Maximum Limits of		
	Test Weight Per Bushel	Sound Cultivated Oats	Heat Damaged Kernels	Foreign Material	Wild Oats
	Pounds	Percent	Percent	Percent	Percent
1[1]	34	97	0.1	2.0	2.0
2[2]	32	94	0.3	3.0	3.0
3[3]	30	90	1.0	4.0	5.0
4[4]	27	80	3.0	5.0	10.0

SAMPLE = sample grade shall be oats which do not meet the requirements for any of the grades No. 1 to No. 4, inclusive; or which contain more than 16.0 percent of moisture; or which contain stones; or which are musty or sour, or heating; or which have any commericially objectionable foreign odor except of smut or garlic; or which are otherwise of distinctly low quality.

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[1] The oats in grades No. 1 White oats may not contain more than 5.0 percent of red oats. gray oats, and black oats, singly or in combination, of which not more than 2.0 percent may be black oats.

[2] The oats in grade No. 2 White oats may contain not more than 3.0 percent black oats.

[3] Oats that are slightly weathered shall be graded not higher than No. 3.

[4] Oats that are badly stained or materially weathered shall be graded higher than No. 4.

HARD RED WINTER WHEAT

		Maximum Limits of				
		Damaged Kernels			Wheat of Other Classes	
Grade	Minimum Test Weight Per Bushel	Total	Heat-Damaged Kernels	Foreign Material	Total	Durum and/or Red Durum
	Pounds	Percent	Percent	Percent	Percent	Percent
1*	60	2.0	0.1	0.5	5.0	0.5
2*	58	4.0	0.2	1.0	5.0	1.0
3*	56	7.0	0.5	2.0	10.0	2.0
4	54	10.0	1.0	3.0	10.0	10.0
5	51	15.0	3.0	5.0	10.0	10.0

SAMPLE = Sample grade shall be wheat which does not meet the requirements for any of the grades from No. 1 to No. 5 inclusive; or which contains more than 15.5 percent of moisture; or which contains stones; or which is musty, or sour, or heating; or which has any commercially objectionable foreign odor except for smut or garlic; or which contains a quantity of smut so great that any one or more of the grade requirements cannot be applied accurately; or which is otherwise of distinctly low quality.

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*The wheat in grades No. 1 and No. 2 of this class may contain not more than 5.0 percent and in grade No. 3 not more than 8.0 percent of shrunken and broken kernels.

The advantages of grading agricultural products are as follows:

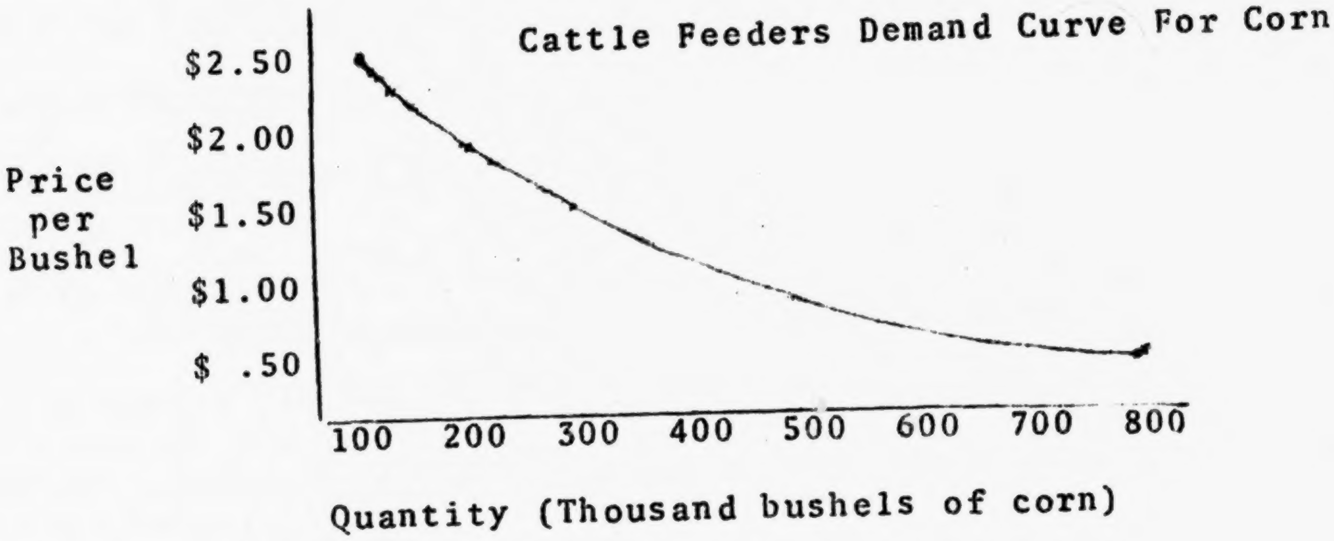
1. Allows for market price quotations based on uniform terminology.
2. Grading encourages the production of higher quality products.
3. Reduces the risk in sales and transportation of agricultural products.
4. Provides a fairer pricing system.
5. Provides an improved product for consumers at a particular price.

In the process of marketing agricultural products, the movement of food from the producer to the consumer requires a high cost. The charges for transportation, processing, wholesaling and retailing farm foods represents a large part of the money the consumer spends for food. The difference between what the farmer receives and what the consumer pays may be referred to as the "marketing margin". The following costs are involved in this "marketing margin"; namely (1) labor, (2) buildings and equipment, (3) containers and supplies, (4) advertising and promotion, (5) transportation, (6) administration, and (7) profits. Labor comprises the largest percentage of the marketing costs, transportation ranks next, depreciation and miscellaneous costs are next, and profits of food processing and marketing firms are about the lowest of these marketing costs. The trend for more packaged and easy-to-prepare foods have resulted in many of these increases in food costs.

Price Determination

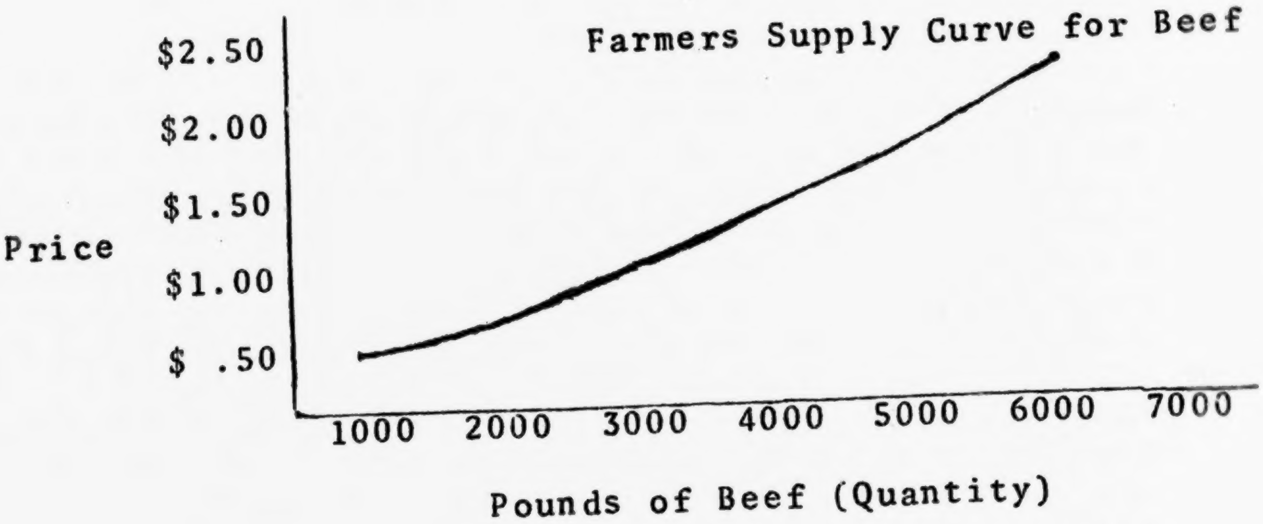
Demand - is the various amounts of a product which a consumer is willing and able to purchase at a specific price. Supply - is the various amounts of a product which a producer is willing and able to produce and make available for sale at a specific price.

For supply and demand figures to be worth while, the price must relate to some specific period of time. The law of demand states that as the price decreases the quantity bought rises and as price increases, the quantity bought decreases. Thus, persons tend to buy more of a product at a low price and less at a higher price. An increase in price causes consumers to look for substitutes, for example as the price of meat increases, the demand for meat tends to shift from the expensive cuts to the less expensive meats. As the price increases such as in meat or dairy products, the consumer generally does not stop buying meat or dairy products but shifts to less expensive products. When plotted on a graph the demand may appear as follows:



Considering the above prices for corn, it seems reasonable to assume that at $2.50 per bushel, a cattle feeder will no doubt look for a substitute for corn in his feeding program and at $.50 per bushel will probably buy all the corn he can find and he probably would enlarge his facility. This assumes all things remain fairly equal.

The rule of supply states that generally as prices rise, the quantity of a product supplied also rises, and as prices fall, the quantity of product supplied also falls. Thus, a farmer tends to produce more of a product as the price decreases. As the price of dressed beef increases farmers get excited about the new price, add more cattle to their feeding set-up, feed to heavier weights and attempt to take advantage of the higher price and as a result produce more meat. When plotting a supply graph, it may appear like the example below:



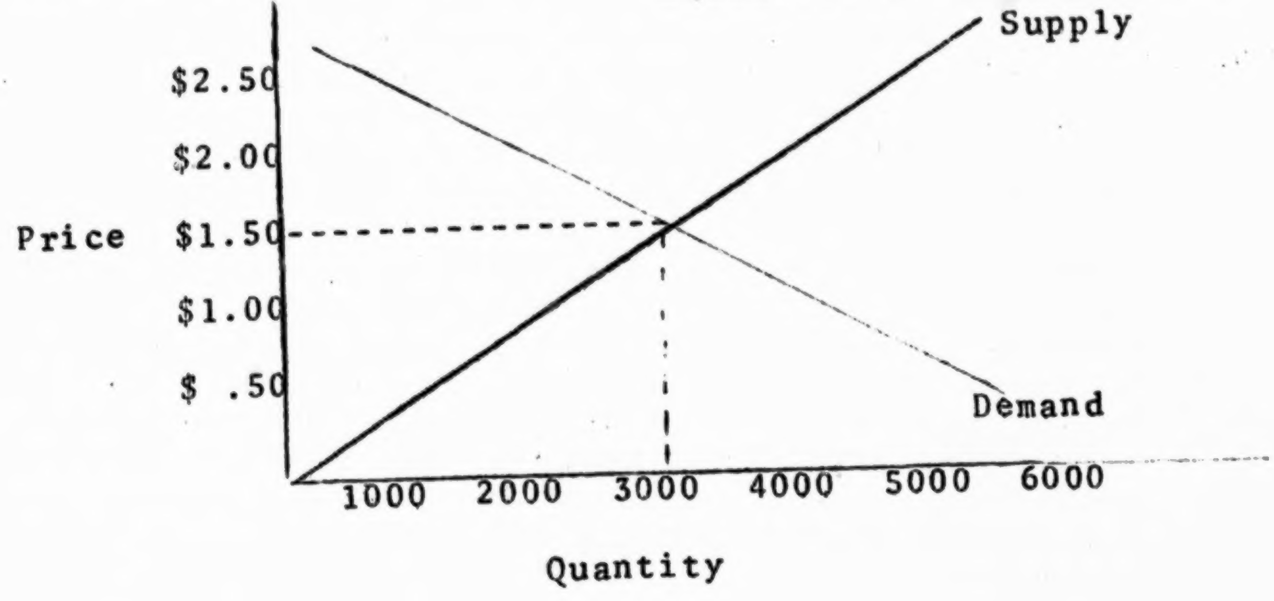
The higher the market price for corn, the more farmers wish to produce corn. One factor which contributes to the supply picture is due to the fact that farmers cannot control the weather conditions. When prices move upward, the farmers may plant a few additional acres, and favorable weather conditions result in larger yields and prices become depressed. It is apparent that as farmers improve their management ability and utilize more chemicals, fertilizer and in some instances water, they will be forced to watch total supply a great deal more and thus, may avoid huge surplus commodities. Farmers, as a whole, will need to be aware of supply and demand as they fit their farm businesses into the total economy. One individual farmer has little influence on the market. A large number of farmers reacting in a similar manner to price and demand changes have a definite effect on the market price.

The following factors effect the demand schedule; namely (1) Preferences and tastes of consumers, (2) Buyer income, (3) Prices of substitute commoditites, and (4) The number of buyers. The following factors effect the elasticity of demand (1) The number of good substitutes available to consumers, (2) the amount the item comprises of a persons total budget, and (3) the necessity, luxury or importance of the item.

The following factors effect the supply of a commodity; namely (1) the prices of materials and supplies needed to produce the commodity, (2) the prices of other commodities or materials which could be produced, (3) the amount of automation and technology used to produce the commodity, (4) the price producers expect, and (5) the number of sellers of the commodity. When producers do not react to price changes, the supply is inelastic. If producers respond quickly to price changes, the supply is elastic. The primary determinant of the elasticity of supply is the amount of time a producer has to respond to a change in price. Farmers are thus producing products that generally are quite inelastic. They must market their livestock, fruit, vegetable and grain crops regardless of the price because some of the products are perishable and become worthless or in the case of livestock, they must be fed and continue to grow and as they become heavier, the desirability of the meat product decreases while their costs of production increase. Thus, farm product supply is relatively inelastic and it takes considerable time to shift to other commodities.

The equilibrium price is the result of neither a surplus or a shortage of a commodity. At this price, the quantity supplied by the producer is in balance with the quantity demanded by consumers. The following figure illustrates that farmers are willing to sell at a certain price and consumers are willing to buy at a certain price:

Equilibrium Price For Corn



The above graph illustrates that when corn is selling for $1.50 per bushel the farmers are willing to sell 3,000 bushels and consumers are willing to pay $1.50 for the 3,000 bushels.

Two other conditions which affect agricultural prices are (1) wartime conditions, and (2) price support programs. Today the government is placing relatively few regulations on the agricultural industry. however, this situation may change as the demand for agricultural products is changed.

In wartime conditions, the demand for food is greatly increased. This is a result of the fact that armies must be fed, and as the nations being overrun by military forces lose their agricultural productiveness, entire nations with millons of war refugees must also be supplied with food. This condition results in a high demand for food. In this situation, prices could become prohibitive for everyone, hence, the government often places a ceiling price on commodities in an attempt to equalize the distribution of food to all people. If equilibrium prices were allowed to be established, it is possible that only the wealthy could afford to purchase the commodity. Generally with the ceiling price, a food rationing system is put into effect to help insure equal distribution.

The second condition which affects agricultural prices is the price support program. The price support program has been used to bolster sagging farm prices which have occured due to a greater amount of production than a demand for the products. This effort is an attempt to increase farm income so that it may compare with other aspects of the economy. Price support programs as such, occur in many areas of the economy. Certain minimum wage laws are passed to improve the incomes of industrial workers, so price supports have been used to improve the incomes of farmers. Price support programs often result in a surplus of production as farmers are willing to produce more than consumers are willing to purchase. Thus, the government must administer a program to deal with a surplus of commodities. The surplus has been handled by developing acreage allotments, and soil conservation programs designed to take the land out of production. The government has also purchased portions of the surplus and disposed of it through a variety of programs such as school lunch and "food for peace" programs. Today, however, the price support programs are of less importance, because agriculture is tending to move toward a market with few regulations by the government. This trend has been due to population growth and the use of agricultural products in world trade which has increased demand and has resulted in less need for governmental price support programs.

Price support programs may not be as successful as expected by governmental agencies because as farmers have reduced acreages, new varieties and technology have enabled farmers to continue to produce at all time high levels.

Some of the characteristics of agricultural production which distinquish them from other industrial products are:

a. Perishability (When a product is ready to be sold, it cannot be stored).
b. Bulkiness (Products require a great deal of grading, packaging and handling before they are ready for consumption).
c. Seasonality of production (Generally limited to warm months of year--crops do not produce continuously).
d. Unpredictability of climatic conditions (Excessive rain ruins a crop; insufficient rain ruins a crop; excessive coolness prevents maturity; windstorm or hail damage ruins production; and diseases or parasites and weeds all reduce production).
e. Labor and machinery use fluctuations. (Machinery can only be used during favorable weather conditions).
f. Variations in land. (Every farm has some variation in land and thus, the same crop cannot be grown on all parts with the same uniformity in growth and development)

As a result of these characteristics, farmers are often prevented from becoming totally specialized or from being able to predict their production levels from year to year. This situation also prevents farmers from being able to guarantee themselves a consistent price.

Storage of Wheat or other Grains:

A. Function: To have the product available at the desired time. Storage is the means of matching production to consumption over time. It is necessary in agriculture because most agricultural crops are harvested in a concentrated period but are consumed rather evenly throughout the year.

B. Costs of Storage

1. Fixed Costs
    a. Depreciation
    b. Insurance
    c. Taxes
    d. Interest on investment

2. Variable Costs
    a. Insurance on the grain
    b. Aeration
    c. Fumigation
    d. Repairs
    e. Shrinkage
    f. Handling

C. Farm Storage versus Elevator Storage

1. Advantages of off-farm storage
    a. No risk to producer in loss due to quality deterioration or due to quantity.
    b. Often are better storage facilities.
    c. Pay only for space used.
    d. May eliminate some costs of moving grain in and out of farm storage.

2. Advantages of farm storage
    a. Earn storage income.
    b. May speed up harvest.
    c. May utilize farm labor more effectively.

VI. REFERENCES:

How to Market Grain, Minneapolis Grain Exchange, Paul S. Amidon and Associates, Inc., Minneapolis, Minnesota, January, 1958.

Hamilton, James E., and W. R. Bryant, Profitable Farm Management, Prentice-Hall Inc., Englewood Cliffs, New Jersey, Second Edition, 1963.

McConnell, Campbell R. Elementary Economics Principles, Problems and Policies, McGraw-Hill Book Company, Inc., New York, N.Y., 1960.

Williams, Willard F. and Thomas T. Stout, Economics of the Livestock Meat Industry, The Macmillan Company, New York, New York, 1964.

Hall, I. G. and W. P. Mortenson, The Farm Management Handbook, 4th Edition, Interstate Printers and Publishers, Danville, Illinois, 1963.

Snowden, Obed L. and Alvin W. Donahoo, Profitable Farm Marketing, Prentice-Hall, Englewood Cliffs, New Jersey, 1960.

Doane Agricultural Digest or Doane Farm Management Guide, Doane Agricultural Service, Inc. 8900 Manchester, St. Louis, Mo. 63144.

UNIVERSITY
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NEBRASKA

ED035773

STUDENT WORKSHEETS ON PRINCIPLES IN AGRICULTURAL MARKETING AND MANAGEMENT

(Supplement to Publication No. 10)

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
Dr. James T. Horner Chairman
University of Nebraska
In Cooperation With
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

VT010344

This publication was prepared in furtherance of a project supported by a grant from the U. S. Department of Health, Education, and Welfare, Office of Education, entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming." The Project was initiated by the Department of Agricultural Education of the University of Nebraska, and has been designated DAVR Project No. 001-65, and Contract No. OE-05-85-020.

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TO THE STUDENT

The discussion questions in this publication have been developed to supplement the material presented in the publication entitled "Principles in Agricultural Marketing and Management."

This publication consists of a variety of questions which are designed to briefly summarize the materials presented in each principle area. The questions are of a discussion type, multiple choice, true and false or completion. These questions attempt to emphasize the important points covered in each principle area. Upon completion of the questions, the student should have a rather complete resume of the information pertaining to agricultural marketing and management.

The questions may be answered by writing directly in this publication or by placing answers on additional sheets of paper.

It is recommended that each section of this publication be completed after the entire principle area has been discussed and practical applications have been made by the teacher and students.

Assignment
Worksheet No. 1

PRICING

Assignment:

1. Review class notes.
2. Review the suggested references.
3. Complete the following questions.

References:

How to Market Grain, Minneapolis Grain Exchange, Paul S. Amilon and Associates, Inc., Minneapolis, Minnesota, Jan. 1958, pp. 1-24.

Hamilton, James E. and W. R. Bryant, Profitable Farm Management, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 2nd Edition, 1963, pp. 343-347.

McConnell, Campbell R., Economics, Principles, Problems, and Policies, McGraw-Hill Book Company, New York, New York, 3rd edition, 1966, pp. 59-77, 410-430.

Hall, I. F. and W. F. Martenson, The Farm Management Handbook, 4th edition, The Interstate Printers and Publishers, Danville, Illinois, 1963, pp. 209-279.

Questions:

1. What is meant by the law of supply and demand?

2. Agricultural products generally have an (inelastic, elastic) demand and supply.

3. What is the futures market?

4. How are hedging and speculation related?

5. Define the following terms:

   Elasticity -

   Inelasticity -

   Short run -

   Long run -

6. Fill in the grades of market livestock.

Beef	Veal	Lamb	Pork	Poultry

7. What advantages are there to grading agricultural products?

8. Why do price support programs often result in surplus production of agricultural products?

9. How may weather conditions cause a drop in farm prices?

10. How are prices determined?

11. What different methods may a person use in marketing beef cattle?

12. What factors should a farmer consider in determining the most profitable marketing method?

13. What appears to be the trend in livestock marketing today?

14. The demand schedule is effected by the following factors?

15. What factors affect the supply of a commodity?

16. Elasticity of demand is affected by the following factors:

17. What is meant by an equilibrium price?

18. What is a ceiling price?

19. Why are price support programs becoming less important today?

20. A terminal market serves what purpose?

21. T F Increasing marketing costs are the primary reason for rising food prices.

22. T F Farm prices are keeping pace with the inflationary price levels of the entire U. S. economy.

23. How does technological advancement affect supply and demand?

UNIVERSITY
OF
NEBRASKA

TEACHER'S KEY
FOR
STUDENT WORKSHEETS
ON
PRINCIPLES
IN
AGRICULTURAL
MARKETING
AND
MANAGEMENT

(Supplement to Publication No. 10)

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
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William Gillies	Consultant
James D. Greer	Consultant
Glen J. Vollmar	Consultant

TO THE TEACHER

This publication is designed to assist the Vocational Agriculture teacher in checking the answers written in the publication entitled "Student Worksheets On Principles In Agricultural Marketing and Management."

The purpose of the student worksheet is to provide the student an opportunity to review the material studied in each principle area. The key to teaching agriculture with the basic underlying principle approach is to allow the students to discover the principle. Hence, the student worksheets should not be used until the entire principle area has been completed. After students have discovered the principle and made appropriate applications in agricultural marketing and management, the worksheets will provide a review of the principle area. Therefore, the student worksheets on each principle area should be given to students one-at-a-time.

The teachers key provides the answers for the questions in the student worksheets. The key may be used by the teacher or the student when correcting the answers.

Answer Key
Assignment
Worksheet No. 1

PRICING

Answers:

1. The law of supply says that as prices rise the quantity of a product supplied also rises, and as prices fall the quantity of a product supplied also falls. The law of demand states that as the price decreases the quantity demanded rises and as price increases, the quantity demanded decreases. Thus, the law of demand and supply: when supply is heavy the price goes down. When demand is heavy, the price goes up.

2. Inelastic

3. The futures market is the market where a contract may be sold or bought that is to be carried out or completed at some future date.

4. Hedging is made possible through purchase and sale of contracts. These contracts call for delivery of a commodity at a future date agreed to by lawyers and sellers. The owners of futures contracts have a laim against a physical inventory of grain or beef to be delivered at a specific date. Hedging is a form of insurance and protects the owner against the risk of a price change. If a person buys grain on the cash market, he may sell a futures contract against it, thus insuring himself of a particular price. If he sells grain on the cash market, he may buy a futures contract against it, thus he insures himself against price changes.

5. Elasticity - is referred to as the responsiveness of consumers and suppliers to a change in the price of a product.

   Inelasticity - is referred to as the resistance or slowness of consumers and suppliers reaction to change in the price of a product.

   Short run - refers to the fact that some resources are fixed but some are also variable. In a short period only some changes can be made.

   Long run - refers to the fact that all resources are variable and everything can be changed.

6.

Beef	Veal	Lamb	Pork	Poultry
Prime	Prime	Prime	U.S. No. 1	A Quality
Choice	Choice	Choice	U.S. No. 2	B Quality
Good	Good	Good	U.S. No. 3	C Quality
Standard	Standard	Utility	Medium	Rejects
Commercial	Utility	Cull	Cull	
Utility	Cull			
Cutter				
Canner				

7. 1. Allows for market price quotations based on uniform terminology.
   2. Grading encourages the production of higher quality products.

   3. Reduces the risk in sales and transportation of agricultural products.
   4. Provides a fairer pricing system.

   5. Provides an improved product for consumers at a particular price.

8. This happens because farmers are willing to produce more with the higher prices than consumers are willing to purchase.

9. Favorable weather conditions may result in large yields or increased supply. With demand remaining constant, this increase in supply results in depressed prices.

10. Prices are determined by the interaction of supply and demand. If demand is great and supply is constant, prices will increase. If supply is increased, and demand remains the same, then prices will decline.

11. 1. Selling directly to the packer or packer-buyer.

    2. Ship to a central market and consign to a commission firm.
    3. Sell to a private buyer, who buys from the feeder and either sells directly to the packer or ships to a central market.
    4. Cooperative marketing

    5. Public auction.

12. 1. Time
    2. Transportation
    3. Grade of product
    4. Quality of product
    5. Competition
    6. Size of lot

13. Decentralization, increased use of the direct market procedure.

14. 1. Preferences and tastes of consumers.
    2. Buyer income
    3. Prices of substitute commodities
    4. The number of buyers

15. 1. The prices of materials and supplies needed to produce the commodity.
    2. The prices of other commodities or materials which could be produced.
    3. The amount of automation and technology used to produce the commodity.
    4. The price producers expect.
    5. The number of sellers of the commodity.

16. 1. The number of good substitutes available to consumers.
    2. The amount the item comprises a persons total budget.
    3. The necessity, luxury or importance of the item.

17. Equilibrium price is the result of neither a surplus or a shortage of a commodity. At this price, the quantity supplied by the producer is in balance with the quantity demanded by consumers.

18. Ceiling price is a price imposed by the government which says that a product may go no higher than the set limit or ceiling.

19. Population growth and use of agricultural products in world trade has resulted in less need for governmental price support programs.

20. The terminal market provides an opportunity for sellers of products to meet with the buyers.

21. True

22. False

23. Technological advancement increases supply while demand remains constant causing prices to go down.

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APPENDIX C

Agricultural Supply, Sales, and Service Occupations

  Part I--General Information

  Part II--Feed Sales and Service Occupations

  Part III--Fertilizer Sales and Service Occupations

  Part IV--Crop, Lawn and Garden Seed Sales and Service Occupations

  Part V--Petroleum and Petroleum Products Sales and Service Occupations

A Syllabus for General Related Instruction for Off-Farm Agricultural and Diversified Occupations in Nebraska

Tractor Repair and Maintenance Course of Study

VT010311

ED035773

UNIVERSITY OF NEBRASKA

AGRICULTURAL SUPPLY, SALES, AND SERVICE OCCUPATIONS

General Information

Part I

James T. Horner

C. Edward Henderson

Appc Pt1

Publication No. 5

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
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Lincoln, Nebraska

VT010311

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INTRODUCTION

The individual study materials developed for use by students preparing for occupational entry in the Agricultural Supply -- Sales and Service occupations is composed of five parts. Part I includes study of career opportunities, salesmanship, organization and function of agricultural businesses, business procedures, and keeping agricultural accounts in agricultural supply -- sales and service occupations. Part I is prerequistie to study in any of the other four parts and could be taught through group instruction. Once the student has completed his study of Part I, he should select one of the remaining four parts and continute his study. The remaining four parts are concerned with the study of technical information needed by persons employed in the various agricultural supply -- sales and service areas. These include retail livestock feed distribution; fertilizer distribution; crop, lawn and garden seed sales; and the sale of petroleum products to farmers.

In preparing this course of study, it has been assumed that development of occupational competency in any type of work involves:

1. Mastery of the abilities, skills and understandings performed by the worker in the occupation.
2. Comprehension of the technical and related information basic to an understanding and practice of the occupation.
3. Development of those personal-social traits which are essential for the successful worker.

In developing the above abilities, skills, and understandings in an off-farm agricultural occupations program, it is necessary for both cooperating agencies -- the school and the employer -- to understand clearly their responsibilities in the training of student workers. Experience has shown that most of the skills and abilities required for entry into an occupation can best be developed through work experience on the job and that the school can best provide instruction in the technical and related occupational information needed by student trainees. As a result, it is expected that the student-worker will master the job skills and procedures through practical on-the-job experience under the immediate supervision of the employer, and that he will receive instruction in related occupational information in the school under the direction of the coordinator.

Skills and related information are matters for specific instruction, but personal-social traits are acquired only through daily usage. Therefore, both the employer and the school must assume responsibility for developing in the student those habits, attitudes, and character traits which are essential for occupational success. Both the employer and the school should be constantly on the alert to make sure that the student-worker places desirable interpretations on his experiences.

Since the coordinator's class will be composed of five to 20 students studying a number of different occupations with varying requirements, it will be impossible for him to teach, through group methods, the occupational information which relates to the specific job of each student. In order to be effective, this type of instruction must be individualized. There is some related information, such as employer-employee reactions, taxes and social security, workers and unions, occupational health and safety, and fair labor standards which are of common interest and concern to all student-workers. These may be effectively taught through group instruction. These areas of instruction are referred to as related instruction in this course of study and constitute approximately one-half of the classroom instruction or the equivalent of 90 hours. However , if the contribution to the in-service training of his students, he must devote approximately one-half of his classroom instruction to content dealing specifically with the work of each individual student. This instruction is referred to as specific related instruction in this course of study.

Each part of the course of study is comprised of two separate publications. The publication entitled "Supervised Course of Study" contains the assignments to be completed by the student. Each assignment includes a general introductory statement, specific materials to read, references that include the readings, and activities to be completed by the student that relates directly to the assignment. The publication entitled, "Question Manual", includes short quizzes over each assignment. These quizzes are to be used by the student to assess his understanding of the materials he has studied in each assignment. Answer keys have been prepared for each part of the course of study to enable the coordinator to score quickly the objective tests which are a part of each assignment sheet. These keys give the correct answers to the questions as well as the references and the page on which each answer may be found. The key sheets should be kept in the coordinator's or instructor's possession.

It is important that instruction in the related information (information related to the occupation for which the student is preparing) be provided in the school at the time it will be used most advantageously on the job. On-the-job training and individual study should parallel each other throughout the student's study. With this arrangement, the coordinator or instructor will become, during a major portion of his classroom time, a study supervisor and helping teacher.

TO THE STUDENT

Agricultural Supply -- Sales and Service is a combination of various occupations needing competencies in agriculture for advancement in the selling, supplying, and management areas of agricultural businesses. This study guide has been prepared to give needed instruction in the area of career opportunities, salesmanship, organization, and function of agricultural businesses, business procedures, keeping agricultural accounts, and sales, supply and service of the following products: feed, fertilizer, crop seed, lawn materials, garden seeds, and petroleum products. Since this is a wide and varied field, you should work with your coordinator and employer to select those areas needed by you in your occupational instruction.

A large proportion of the agricultural businesses in Nebraska are operated by proprietors or managers with few employees. The wider the services and supplies rendered, the more employees needed. The larger businesses are usually operated as partnerships, corporations, or cooperative associations having a variety of jobs for which they need employees.

The beginning employee in the small business is usually expected to store and handle stock, wait on customers both in buying and selling, and possibly do delivery work. Since the number of employees is usually small, one has a good opportunity to become familiar with all phases of the business. In the larger cooperatives or corporations an employee has an opportunity to become more specialized and may work continuously in only one phase of the business.

Individual student wages may vary according to the size of business, type of work, and community; but are usually consistent with beginning wages in other retail and industrial occupations. Opportunity for advancement depends on the ambition, energy, ingenuity, and desire of the individual. A person showing these desirable qualities may advance to positions of responsibility such as managers, assistant managers, foreman, or sales supervisors. The larger businesses such as cooperatives and corporations usually prefer beginning employees with some background, training, and experience in agriculture.

The contents of these study guides are designed to prepare student for initial entry in the following occupational areas:

Retail livestock feed distribution
Retail seed distribution
Retail fertilizer distribution
Grain handling and storage
Agricultural supplies sales
Rural petroleum products distribution

The information in these guides is designed to prepare you for initial entry into the above occupational areas. With experience gained through on-the-job instruction you will be able to advance to higher positions within the occupational area that you have chosen to enter. Listed below are the specific occupations that you will want to consider as you prepare yourself for initial employment. Your choice of the occupation which you plan to enter and the depth and breadth of the material that you should study should be made after you have consulted with your instructor and probably employer.

SALESMAN (ret. tr.; whole. tr.). Sells merchandise to business or industrial establishments, or to individuals, utilizing detailed knowledge of specific characteristics, of merchandise, at sales office, store, showrooms, or customer's home or place of business: Calls on customer in person or by phone, or talks to customer on sales floor. Displays merchandise, using samples or catalog. Demonstrates article, emphasizing salable features. Estimates or quotes prices, credit terms, and trade-in allowances. Prepares forms and sales contracts. Prepares reports of business transactions and keeps expense accounts. May set up window displays and advertising posters. May collect payment of products sold. May install commercial, industrial, or household equipment and instruct buyer in use or operation.

SALESMAN, GRAIN-AND-FEED PRODUCTS (whole. tr.). Sells grain and feed-mill products, such as flour, feed, meal, and cereals,performing duties as described under SALESMAN (ret. tr.; whole tr.). Suggests feed changes to improve breeding of fowl and stock. Draws up contracts to furnish customers flour for fixed period and price. May be designated according to product sold as SALESMAN, COMMERCIAL FEED; SALESMAN, FLOUR AND CEREALS.

SALESMAN, BUILDING AND CONSTRUCTION EQUIPMENT AND SUPPLIES (whole. tr.) 276.358. Sells building materials, equipment, and supplies, such as heating or air-conditioning equipment, building insulation, bricks or lumber, plumbing fixtures, and roofing, utilizing knowledge of building construction and ability to read blueprints. Performs other duties as described under SALESMAN (ret. tr.; whole. tr.).

SALESMAN, PETROLEUM PRODUCTS (whole. tr.) 267.358. Sells petroleum products, such as gasoline, oil, greases, and lubricants, performing duties as described under SALESMAN (ret. tr.; whole. tr.).

SALESPERSON, GENERAL HARDWARE (ret. tr.; whole. tr.) 276.358. floor clerk, hardware. Displays and sells hardware, such as builder's hardware, electrical equipment, gardening tools and equipment, household hardware, paints, plumbing supplies, and woodworking equipment, performing duties as described under SALESPERSON: Advises customer concerning quality and demonstrates uses of hardware, tools, and equipment. Performs other related duties, such as estimating amount of paint required to cover given area, advising customer on methods of mixing paint, cutting screen or wire to specified lengths, and cutting glass. May specialize in selling paint and be designated as SALESPERSON, PAINT.

SALESMAN, CATTLE-AND-POULTRY FOOD SUPPLEMENTS (ret. tr.) 277.358. Sells poultry and livestock feed supplements to farmers, performing duties as described under SALESMAN (ret. tr.; whole. tr.).

SALESMAN, FARM AND GARDEN EQUIPMENT AND SUPPLIES (whole, tr.) 277.358. Sells farm and garden machinery, equipment, and supplies such as tractors, feed, fertilizer, seed, insecticide, and farm and garden implements, performing duties as described under SALESMAN (ret. tr.; whole. tr.).

SALESMAN, POULTRY EQUIPMENT AND SUPPLIES (ret. tr; whole. tr.) 277.358. Sells poultry equipment and supplies, such as brooders, coolers, feeders, graders, and washers, performing duties as described under SALESMAN. May sell chicks. May advise customers on care and feeding of poultry, setting up of poultry equipment, egg production problems, and suggest remedial measures for diseased or sick poultry. May tend battery of brooders to hatch chicks.

SALESPERSON, LAWN AND GARDEN EQUIPMENT AND SUPPLIES (ret. tr.; whole. tr.) 277.358. Sells lawn and garden plants supplies, and equipment, in nursery, greenhouse, or department store, performing duties as described under SALESPERSON: Advises customer on methods of planting and cultivating plants and use of gardening tools and equipment, Suggests suitable trees and shrubbery for planting in certain soils and climates. Waters and trims growing plants on sales floor. Gives horticultural advice to customer.

SALESMAN, GENERAL (ret. tr.; whole. tr.) 289.358. Displays and sells variety of commodities to customers at sales office or customer's place of business or home: Displays merchandise, samples, or shows catalog. Describes selling points of merchandise, such as economy, durability, and appearance. Performs duties as described under SALESMAN.

PEST-CONTROL WORKER 465.381. Locates and exterminates plant and tree pests and diseases: Searches fields, brush trees, and warehouses to locate plant pests, such as witchweed, boll weevil, Japanese beetle, soybean cyst nematode, fire ant, gypsy moth, white-fringed beetles, and army worms. Mixes exterminating agents, such as herbicides, insecticides, and fungicides, according to type of infection or infestation to be treated. Applies exterminating agents using spray equipment. Destroys clusters of typse-moth eggs by painting or spraying clusters with cresote. Collects samples of infected soil or plants for laboratory analysis. Marks infested area to determine effectiveness of treatment. May specialize in treatment of one type of infestation, such as gypsy moth or witchweed.

SPRAYER (agric.) 424.883. chemical applicator; duster operator; machine duster; speed sprayer. Sets up and operates equipment to dust tree crops, ground crops, and livestock with liquid or powdered pesticides, fertilizers, herbicides, or hormones: Installs and adjusts spray jets according to crop or materials used and adjusts fan louvers to control airflow, using handtools. Mixes specified materials and dumps them into hopper of machine. Drives vehicle to pull sprayer through crop fields, and starts mechanism to dust crops, or installs equipment in animal chute or pen to spray livestock. May be designated according to crop dusted as FRUIT SPRAYER: LIVESTOCK-SPRAY-MACHINE OPERATOR: ORCHARD SPRAYER: TREE SPRAYER: VEGETABLE SPRAYER.

AUTOBOBILE-SERVICE-STATION ATTENDANT (auto. ser.) 915.867. automobile-service-station salesman; filling-station attendant, gasman; gasoline-station serviceman; gas-station attendant; gas tender; pumpman; salesman, gasoline; salesman, oil; service-station attendant.

Services autobobiles, buses, trucks, and other automotive vehicles with fuel, lubricants, and accessories: Fills fuel tank of vehicles with gasoline or diesel fuel to level specified by customer. Observes level of oil in crankcase and amount of water in radiator, and adds required amounts of oil and water. Adds necessary amount of water to battery, and washes windshield of vehicle. Lubricates vehicle and changes motor oil (LUBRICATION MAN). Replaces accessories, such as oil filter, air filter, windsheild-wiper blades and fan belt. Installs antifreeze and changes spark plugs. Repairs or replaces tires (TIRE REPAIRMAN). Replaces lights, and washes and waxes vehicles. Collects payment for services and supplies in cash or by completing credit card sales form. May adjust brakes (BRAKE ADJUSTER). May sell batteries and automobile accessories usually found in service stations. May assist in arranging displays, taking inventories, and making daily reports.

TIRE REPAIRMAN (auto. ser.) 915.884. tire-and-tube repairman; tire-and-tube serviceman; tire fixer; tireman; tire serviceman. Repairs damaged tires of automobiles, buses, trucks, and other automotive vehicles: Raises vehicle, using hydraulic jack, and unbolts wheel using lug wrench. Removes wheel from vehicle by hand or, when repairing gia nttires of heavy equipment, by use of power hoist. Locates puncture in tubeless tire by visual inspection or by immersing inflated tire in water bath and observing air bubbles emerging from puncture. Seals puncture in tubeless tire by inserting adhesive material and expanding rubber plug into puncture, using handtools. Separates tubed tire from wheel, using rubber mallet and metal bar or mechanical tire changers. Removes inner tube from tire and inspects tire casing for defects, such as holes and tears. Glues boot (tire patch) over rupture in tire casing, using rubber cement. Inflates inner tube and immerses it in water to locate leak. Buffs defective area of inner tube, using scraper, and patches tube with adhesive rubber patch or seals rubber patch to tube, using hot vulcanizing plate. Reassembles tire onto wheel, and places wheel on balancing machine to determine counterweights required to balance wheel. Hammers required counterweights onto rim of wheel. Cleans sides of white wall tires and remounts wheel onto vehicle. Responds to emergency calls to make repairs or replacements of damaged tires at customer's home or on road. May be designated according to specialty as GIANT-TIRE REPAIRMAN: TIRE CHANGER: ROAD SERVICE.

SPRYER, HAND (agric.) 465.887. Sprays tree crops, ground crops, or livestock with pesticides, fertilizers, herbicides, and hormones: Attaches hose to pipeline of stationary pump or outlet on portable sprayer. Opens valve, adjust sprayer nozzle, and directs spray over crop or livestock. May fill sprayer tanks.

FEED MIXER OR FEED BLENDER (corn prod.) 520.885. Tends agitator tubs that blend ingredients used in making stock feed: Turns valves to admit measured amounts of materials, such as bran, gluten, and steep water, to tubs and starts paddle agitators. Feels sample of mixture to determine if feed consistency meets plant standard. Pulls lever to open sliding gate and drain mixture from tubs.

FEED-MIXER HELPER (grain & feed mill). 520.886. feeder loader; hopper loader; mixer-machine feeder; mixer-man helper. Assists FEED MIXER in preparing stock and poultry feed by dumping sacks of wheat, corn, or other ingredients into hopper of mixing machine. Stirs ingredients in hopper, using paddle, to facilitate flow into mixer. Performs other duties as described under HELPER (any ind.)

FEED WEIGHER (corn prod.) 920.885. laborer, feed elevator; packer. Tends machine that fills and sews tops of sacks of stockfeed: Shakes bag open, places it under chute, and presses pedal which releases preweighed batch of feed into sack. Lifts filled sack on bag-closing machine conveyor, folds end of sack, and clamps sewing unit in place. Starts sewing device which automatically sews tops of bag. May sew tops of filled sacks by hand. May weigh filled sacks, using platform scales (WEIGHER (any ind).

MILL FEEDER (grain and feed mill). 520.885. Tends machine that mixes meat scraps, used in poultry feed, into uniform mixture: Starts machine and opens slide gates in hopped to feed scraps into machine. Observes meter and adjusts slide gates in feed hopper to regulate flow of material into machine.

FLOUR-BLENDER HELPER (grain and feed mill). 520.886. blender helper; bolter helper; feed-in man; flour-dumper helper; flour-mixer helper. Fills hopper of blending machine with flour to assist FLOUR BLENDER: Moves sacks of flour from storeroom to blending machine, using handtruck. Cuts sacks open and dumps contents into hopper of machine or turns hand screws or moves levers to adjust gate openings of overhead storage bins to release specified amounts of flour into blender hopper. Performs other duties as described under HELPER (any ind.)

FOOD MIXER (grain and feed mill). 520.887. Prepares bird foods by mixing together specified amounts of liquid and solid ingredients. Packs product into molds or containers.

GRINDER OPERATOR (grain and feed mill). 521.782. feed miller; gristmiller; meal man; mill operator; roller-mill operator. Operates bank of roll grinders to grind grain into meal or flour: Opens and closes slides in spouts to route grain to various grinders and sifters. Turns wheels to adjust pressure of grinding rollers for each break (passage of grain between rollers) according to grain size and hardness, and adjusts feed chutes to regulate flow of grain to rollers. Inspects product tactfully and sifrs out chaff to determine percentage of yield. Adjusts rollers to maintain maximum yield. Replaces worn grinding rollers, using handtools. May sift and bolt meal or flour. May clean and temper grain prior to grinding. May direct workers who drain and temper grain and bolt meal or flour. May be designated according to grain milled as CORN MILLER.

FEED GRINDER (grain and feed mill). 521.885. Tends machines that grind, cut, crimp, shell, or roll grain, hay corncobs, chaff, and screenings for stock and poultry feed: Opens chute to regulate flow of grain into machine or pitches hay and corncobs into machine hopper. Starts machine and adjust control to regulate speed according to fineness of grind specified. May tend separator that cleans grain prior to grinding or to sift ground grain. May start conveyors and elevators to transfer processed feed to storage or packing machine bins. May fill sacks and weigh on platform scale. May be designated according to machine tended as CORN-CUTTER OPERATOR: CORN-SHELLER OPERATOR: CRIMPER OPERATOR: CRUSHER-MACHINE OPERATOR: HAMMERMILL OPERATOR: ROLLED-OATS-MILL OPERATOR.

GRAIN-DRIER OPERATOR OR DRIER ATTENDANT (grain & fee mill). 523.885. Tends grain-drying machines that reduce moisture content of grain: Receives data concerning moisture content of grain to be dried. Moves levers to regulate gate on feed hopper and flow of grain through drier. Observes temperature recorders and turns valves to regulate flow of steam pressure or gas to heat driers to specified temperature. May observe conveyors transferring grain from storage bin and control flow of grain into feed hopper. May test grain to insure moisture content standards are being met, using moisture meter or standard oil-distillation test. May be designated according to grain dried as RICE-DRIER OPERATOR (grain & feed mill).

CUSTOM-FEED MILL OPERATOR HELPER (grain & feed mill). 521.886. Assists CUSTOM-FEED MILL OPERATOR in milling grain and feed to customer specifications. Sacks and loads mill products on truck and delivers them to customer. Performs other duties as described under HELPER (any ind.)

BIN CLEANER (grain & feed mill; malt liquors). 529.884. sanitation man. Scrapes, scours, and fumigates interior of grain bins: Climbs into grain bin or lowers self into bin on scaffolding or bucket seat, using block and tackle. Cleans interior of bin, using hand scrapers and brushes. Sprays interior of bin with insecticides and rodent deterrents or poisons, using spray gun. Closes bins for specified length of time. Airs bin and marks it for use. Places rodent traps and powders in designated areas in elevator. Keeps inventory of insecticides and rodent control supplies.

GRAIN MIXER (grain & feed mill). 520.885. grain blender; transfer man. Tends equipment to mix grain for milling into blended flour: Starts belt conveyor and adjusts valve controls on automatic feeders to regulate proportions of specified grades of grain flowing from storage tanks onto converyor. Starts conveyors to transfer grain to milling department. May inspect grain for smut, rust, or other contamination. May find weight of minimum test bushel by filling standard measure with grain and recording weight.

GRAIN PICKER (grain & feed mill). 529.687. grader. Separates and weighs samples of grain preparatory to grading: Pours grain sample into hopper of sample divider and pulls lever to allow grain to fall through divider into two receptacles. Removes and weighs specific amount of grain from each receptacle to obtain a representative but reduced sample. Pours sample into cleaning mill (dockage tester) or through sieve of standard mesh to remove foreign matter. Smells and examines sample to determine if grain is sour or musty or to detect damage from excessive heat or moisture. Pours grain sample into standard quart kettle, weighs sample, and reads conversion chart to obtain weight per bushel. Separates damaged, weathered, soil-stained, and undeveloped grain from grain with no defects and places grain in separate containers. May remove grain sample from incoming shipments (GRAIN SMAPLER (finan. inst; whole. tr.)

GRAIN RECEIVER (corn prod.) 921.885. elevator man. Weighs carload shipments of grain, such as corn or milo, and starts conveyors to route batches of grain to steep tanks: Weighs car spotted on scales to record and verify weight against consignment sheet. Notifies MATERIAL HANDLER (any ind.) that car is ready for unloading. Weighs empty car. Starts conveyor to move grain from unloading pit to elevator . Sets batching scale at specified weight and starts conveyor that transfers grain to scale bin until balance is achieved. When notified, pulls lever to empty bin and starts conveyor to transfer grain to steep tanks. Maintains batch records.

GRAIN SAMPLER (finan . inst.; whole. tr.) 229.687. grain prober. Obtains samples of grain from freight cars, boat holds, trucks, and storage bins for grading: Pushes sample-taking device into grain at regularly spaced intervals or, if grain is being loaded, obtains samples from loading spout. Examines samples for uniformity and combines parts to form single sample. Places sample in canvas bags, tags it, and forwards to AGRICULTURAL-COMMODITY GRADER (gov. ser.). Files individual samples of grain that differ from lot and notes estimated quantity represented.

GRAIN WEIGHER (grain & feed mill; malt liquors) 224.587. scaleman; weigher. Weighs railroad carloads of grain moving in and out of elevator, using beam scale: Examines bin slips or track list to determine ty[illegible] destination, and estimated weight of each load. Notifies workers to dump or lead grain cars, using bell, light, or telephone signal system. Pulls lever to open slide gate on storage hopper and drop grain into scale hopper. Weighs grain by setting beam scale to balance. Inserts ticket into automatic recorder on scale that punches weight on ticket. Notifies government inspector to examine beam scale balance and stamped ticket. Records weights, description, and destination of grain. May start conveyors, select flow pipes, set trippers and select storage tanks to convey grain into storage or to loading department.

CONVEYOR OPERATOR (any ind.) 921.883. Controls conveyors or conveyor system that transfer materials from underground workings to vehicles or stockpiles, load or unload vehicles and ships, or move materials or products to and from stockpiles, processes, or departments: Starts conveyor and loads or directs other workers to load conveyor, or adjusts chute or gate or positions pipe into bin or stockpile to permit material to flow onto conveyor. Moves controls to regulate rate of movement and routing of materials or products according to signals or knowledge of process by switching and reversing conveyors, moving delfector bars or gates at intersecting points, or opening and closing chute gates. Dislodges jammed materials or products, using pole, bar , or other handtools or by hand. Observes moving materials or products for obvious defects and operation of equipment for malfunction. Lubricates parts. May adjust conveyor scales and cutoffs to sort and deposit specified kinds and amounts of materials ro containers at process, storage, or shipping areas. May collect samples of materials for analysis. May join sections of conveyor frames at temporary working areas and connect power units. May operate scoop to load materials onto conveyor. May clean materials from under conveyor to prevent jamming and damage. May clean working area. May record data, such as material moved, weight, and operating condition of equipment. May be designated according to product moved as COAL-CONVERYOR MAN: or according to type of equipment as GRAIN-ELEVATOR MAN (grain & feed mill); SCREENMAN (cement); SUCTION MAN (agric.); or according to quantity moved as BULK-LOADER OPERATOR (water trans.).

GRAIN-ELEVATOR-MOTOR STARTER (grain & feed mill). 921.885. Tends motors that drive conveyor belts in grain elevator: Observes lights on wall and stops or starts motors, as indicated. Sweeps floor, cleans motor room, and oils motors.

PROCESSOR, GRAIN (grain & feed mill). 521.885. cleaning-house man; grain cleaner; smutter. Tends grain separating, washing, and scouring machines that remove foreign matter, such as dirt, smut, and rust, from grain preparatory to milling: Adjusts slides in bin spouts and starts elevators to route grain from storage bins to machines. Turns valves to regulate water temperature and water level in washer, to adjust air suction to remove dust from separators, and to regulate flow of air through drier. Turns wingnuts to adjust angle of separator screens according to grain flow and amount of refuse. Hooks bag under end of screen to catch refuse. Starts machines to process grain and observes flow entering machines to prevent overloading. Examines processed grain to verify cleanliness. Pounds chutes with mallet to dislodge clogged grain. May tend separating equipment only and be designated as SEPARATOR TENDER.

LABORER, STORES (any ind.) 922.887. stock boy; warehouseman. Performs any combination of the following tasks to receive, store, ship, and distribute materials, tools, equipment, and products within establishments as directed: Conveys materials and items from receiving or production areas to storage by hand or using truck. Sorts and hangs materials on racks or places items on shelves or in bins according to predetermined sequence, such a size, type, or product code, storing perishable goods in refrigerated rooms. Marks materials or containers with identifying information, using stencil or crayon. Opens bales, crates, and other containers, using handtools. Fills requisitions, work orders, or requests for materials, tools, or other stock itams. Distributes handtools, patterns, fixtures, parts, and other items to workers by placing them on conveyor or truck. Loads materials or products onto skid, pallet, or truck, prepares and attaches shipping tags to load, and moves load to production department or loading platform, using handtruck or powered truck. Stows materials or products in motortrucks or railroad cars. Keeps record of materials or items received or distributed. Pakcs material for distribution within plant, weighing or counting them to insure conformance to company standards. Loads rolls of materials in machine holders. Arranges stock parts in specified sequence for assembly by other workers. Makes repairs to stock items, such as replacing worn or broken drill bits, sharpening knives, and removing rough edges with sandpaper. May be known according to specific task performed as COOLER MAN(dairy prod.); ORDER FILLER: PRODUCE CLERK (ret. tr.); TOOL CHASER.

LUBRICATION MAN (auto ser.) 915.887. greaser; lubrication salesman; lubricarion technician; oiler. Lubricates moving parts of automotive vehicles, such as automobiles, buses, and trucks: Injects grease into units, such as springs, universal joints, and steering knuckles, using hand or compressed-air powered grease gun. Inspects fluid level of steering gear, power steering reservoir, transmission, differential, rear axle housings, shackles, and tires. Lubricates moving parts with specified lubricants. Drains oil from crankcase and refills crankcase with required amount of oil. Sprays leaf springs with lubricant, using spray gun. Adds water to radiator and battery. Replaces oil and air filters. May sell lubrication and safety inspection services and maintain related records on regular customers, following up periodicall with telephone, mail, or personal reminders.

TANK-TRUCK DRIVER (petrol. refin.; ret. tr.; whole. tr.) 903.883. Drives tank truck to deliver gasoline, fuel oil, lubricating oil, or liquefied petroleum gas to customers: Drives truck into position to load at filling rack. Opens valves or starts pumps to fill tank. Reads gauges or meters and records quantity loaded. Drives truck to premises. Connects hose to tank and opens valves. Records amounts delivered and issues ticket to customer. May attach ground wire to truck. May be designated according to type of fuel delivered as FUEL-OIL-DELIVERY MAN: GAS-DELIVERY MAN: May drive trailer truck and be designated TRAILER -TANK-TRUCK DRIVER.

When you arw working out each assignment you should first read the material assigned carefully, then answer the questions in the question manual. Once you have completed the questions, have them checked by your teacher coordinator and go back and rework any that you missed. When there are activities listed these should be carried out to the best of your ability. All the references, including visual and audio-visual aids, should be studied with the utmost of care.

As you begin your study in Agricultural Supply -- Sales and Service occupation you should remember that learning is an individual process. How fast and how well you progress depends entirely on you. You should remember that, no matter what your starting wage, the cost to the employer to prepare you for initial employment will be more than the value of your services for some time. Thus, you owe it to your employer as well as yourself to progress as fast as possible.

Analysis of Part I, General Information
Agricultural Supply, Sales and Service Occupations

ABILITIES: To develop the ability to:		Assign. No.	UNDERSTANDINGS: To develop the understanding of:	
	Career Opportunities			
1	Identify and describe the nature of the work of the sales, supply and management occupations	1	1	The description of and the nature of the work of the sales, supply and management occupations
2	Describe the working conditions of the occupations	1	2	The working conditions of the occupations
3	Give the educational and personal qualifications for the occupations	1	3	The education 1 and personal qualifications for the occupations
4	Describe the entrance and advancement possibilities of the occupations	1	4	How to enter and advance in the occupations
	Salesmanship			
5	Meet the customer	2	5	Techniques of meeting customers
6	Present supplies and services to the customer	2	6	Principles of salesmanship
7	Overcome sales resistance	2	7	Psychology of selling
8	Close the sale	2	8	Factors in closing sales
	Organization and Function of Agricultural Business			
9	Understand types of store ownership	3	9	Types of store ownership
10	Understand organization plans	3	10	Methods of organization planning

Assignment No. 1

BASIC ECONOMICS OF LIVESTOCK FEEDING AND THE LIVESTOCK INDUSTRY

The major objective in livestock feeding is the production of livestock products that gives the producer the maximum net income. This does not always require the lowest feeding cost nor the most rapid rate of gain. It does, however, require a combination of proper feeding with the other factors of production.

Feeding has an effect on rate of gain or production, feed efficiency, and market quality of the finished product. Generally, the greater the rate of gain or level of production, the lower the feed cost; and the higher the market grade, the greater will be the net profit to the producer.

Assignment:

1. Read the references listed below.
2. Answer the questions listed in the question manual and turn in this assignment by ____________________________.

References:

B. Morrison, Feeds and Feeding, pp. 148-160 and 620-640.

Movies:

1. Cattle and The Corn Belt (USA - The Middle West)
   20 min., B&W.

   Explains the importance of the Corn Belt in the production of cattle and other livestock for the nation's meat supply. Shows many scenes of cattle ranches farther west, the feeding yards in the Middle West and cattle yards and processing plants in the cities.

   Bureau of Audio Visual Instruction, University Extension Division, University of Nebraska, Lincoln, Nebraska 68508

2. Meat, Milk and Honey with Livestock on Concrete
   15 min., color.

   The film emphasizes that the secret of livestock production is the careful planning of that production. Disadvantages of raising livestock in muddy lots are indicated.

   Bureau of Audio Visual Instruction, University of Nebraska Extension Division, University of Nebraska, Lincoln, Nebraska 68508

3. Gods Own Corn Country
   30 min., color.

   Shows cattle ranching in the Sandhills of Nebraska where cattle are produced for the feed lots of eastern Nebraska.

   Secretary Manager, Sandhills Cattlemen Association, Valentine, Nebraska

Economics of Livestock Feeding

The following materaial is adapted from information prepared by the Center for Vocational Technical Education, Ohio State University, Columbus, Ohio.

Feed is the major cost of all livestock production, generally resulting in the following percentage of the costs of producing livestock and livestock products.

1. Whole milk - 50-60%
2. Market hogs - 75-80%
3. Poultry - 60-70%
4. Feeder calves - 60-70%
5. Market cattle - 75-85%
6. Market lambs - 60-70%

Costs may be above or below these averages due to the individual producer's ability, quality of livestock, feed prices, and the producer's labor efficiency.

Minimal standards for rate of gain or production and feeding efficiency are given in the following table.

Livestock or Livestock Product	Rate of Gain Level of Production	Feed Efficiency
Whole milk	400 lbs. butter fat annual	25-30 lbs. per day-hay or hay equivalent 6-10 lbs. per day-grain
Market hogs	200 lbs. at 5 months	1 lb. per 3.3 lbs. feed
Poultry--eggs	240 eggs annually	4.0 lbs.per dozen eggs
--broilers	3 lbs. at nine weeks	1 lb. per 2.5 lbs. feed
Feeder calves	450 lbs. at 7 months	1 lb. per 5-6 lbs. milk and feed
Market cattle	2.5 lbs. per day	1 lb. per 7-8 lbs. feed
Market lambs	.33 lbs. per day	1 lb. per 6-7 lbs. feed

$10.00 worth of feed will produce about:

1. 600 pounds of milk
2. 100 pounds of pork
3. 50 dozen of eggs
4. 65 pounds of beef
5. 60 pounds of lamb

These levels of production will vary widely due to climate, value of home-grown feeds, management, and inherited characteristics of the animals. The same is true for feed efficiency.

Other economic losses result from:

1. Proper rations fed at low levels result in nutritional deficiencies as anemia, rickets, ketosis and other diseases that will lower production.

2. Proper rations that are overfed can result in other nutritional diseases that reduce production and cause feed wastage.

3. Improperly prepared rations that are unpalatable or difficult to digest.

Various rations may give equal rate of gain, feed efficiency and a uniform market product but have different costs, which will result in varying net returns. The feed dealer needs to sell a feed that will give the producer the highest net return per animal unit. The success of the livestock producer will determine the success of the feed dealer. Only satisfied customers will continue as repeat customers. The feed industry presently handles 40 million tons of feed, valued at over 3 billion dollars, annually.

THE LIVESTOCK INDUSTRY

It is important for the feed salesman to have some knowledge of the livestock industry. Feed sales depend solely on this industry. The livestock industry is large and is increasing in size every year. Hence the feed sales and service will increase in a like manner. The livestock industry depends on the human population and its consumption of products of this industry.

It would seem that a knowledge of the size of the population in the United States and its projected growth would be of interest to people in the feed business. In 1965 there was about 164 million people in this country. By 1980 it is predicted that there will be an increase of 27% in the population, or about 51 million more people. This means 51 million more customers for human food. This will cause a rise of about 30% in domestic use of farm products. The per capita consumption of meats by 1980 will be up for some kinds of meat and down for others but the overall consumption by the population will be much increased as is shown in the following graphs:

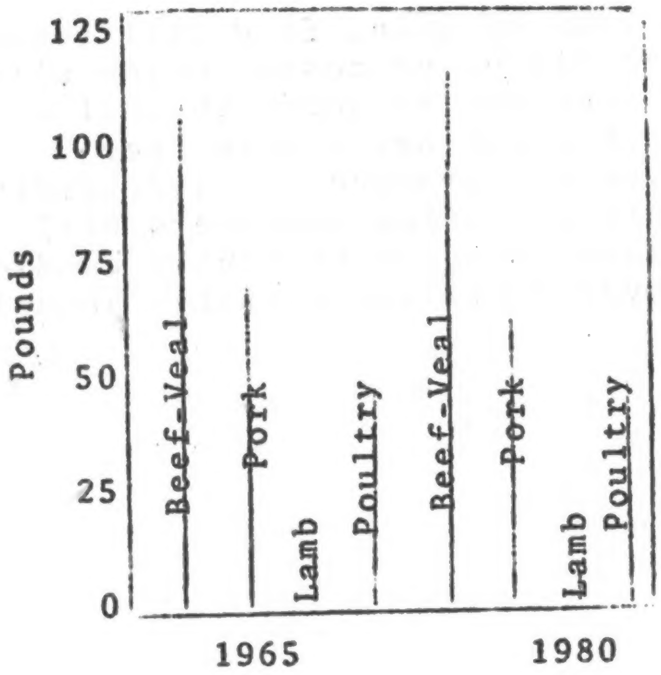

Fig. 1 Per Capita consumption
of meats in U. S.
Source: Furrow
Dec. 1965, John Deere
Moline, Illinois

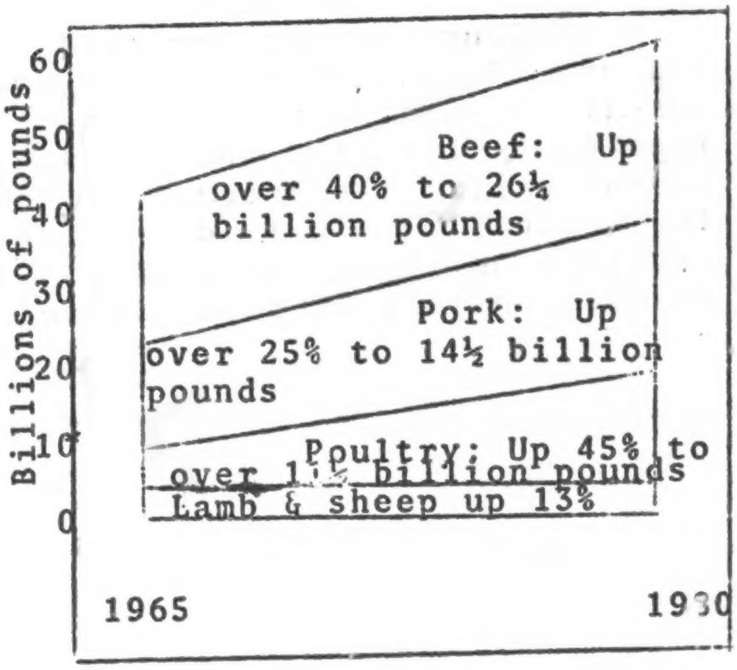

Fig. 2 Total consumption of
meat in all classes.
Source: Furrow
Dec. 1965, John Deere
Moline, Illinois

Figure 1 compares the per capita meat consumption of 1965 to the estimates of 1980. In 1980 beef, lamb and poultry consumption are forecast for increased consumption per capita while there is a predicted decline in pork consumption per capita.

Figure 2 shows the anticipated increase in all classes of meat.

Table 1. Livestock numbers and value in Nebraska, January 1, 1965*

Kind of livestock	Number	Value	1966***
All cattle	6,002,000	$696,232,000	
Beef cattle**	5,565,000	643,149,000	
Hogs and Pigs	2,640,000	68,640,000	
Milk cows, replacement heifers and calves	437,000	53,083,000	
Sheep	605,000	9,566,000	
Chickens	7,253,000	6,238,000	
Turkeys	48,000	202,000	

*Nebr. Ag. Statistics

**Beef cattle here is interpreted to include the beef breeds plus the dairy cattle steers as vealers or fattening stock.

***To be completed by the student as a part of this assignment on a separate sheet of paper.

The total value of the livestock in Nebraska, January 1, 1965 was $780,878,000.

The average annual value of crop production in Nebraska from 1959-1963 amounted to $697,430,000 even though cash receipts were $433,275,000. Part of the livestock receipts in reality represents the marketing of crops since much of the feed grains and legume roughages are fed to livestock.

Nebraska ranks third in the beef cattle industry in the United States. Table 2 lists 10 states and the number of beef cattle in each state.

Table 2. Number of beef cattle on farms and ranches, January 1, 1965, ten states.*

State	1965	1966**
Texas	10,239,000	
Iowa	7,338,000	
Nebraska	5,565,000	
Kansas	5,159,000	
California	4,684,000	
Missouri	4,435,000	
South Dakota	4,278,000	
Oklahoma	4,190,000	
Montana	2,758,000	
Mississippi	2,191,000	

* Livestock and Poultry Inventory, Jan. 1 for years 1961 through 1965.

** To be completed by the student as a part of this assignment on a separate sheet of paper.

15

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Suggested activities to add knowledge relative to the economics of the livestock industry.

1. Check the Nebraska Agricultural Statistics and fill in column 4 in table 2.

2. Review market reports to determine the prices of feed grains, protein feeds, prairie hay and alfalfa hay. Prepare a graph to cover one semester on prices of the common feeds used in the community.

3. Prepare a graph showing the market prices of the following classes of livestock and poultry for a period of one semester. Plot once a week using the same day of the week each time.

Choice fat steers	1000-1200 pounds
Choice fat heifers	900-1000 pounds
Good Feeder steers	650-750 pounds
Butcher hogs	200 pounds
Fat lambs	75-90 pounds
Breeding ewes	100-125 pounds
Broilers	
Hens	

4. Visit several farms and ranches to observe the feeding operations. What equipment is used?

Assignment
Sheet No. 2

STRUCTURE AND FUNCTION OF THE DIGESTIVE SYSTEM

Introduction:

How does an animal utilize the nutrients in the feed it consumes? What are the functions of the parts of the digestive system of an animal in breaking down feedstuffs commonly fed? How are the nutrients moved into the animal body, to become a part of the animal, to produce meat, milk, eggs, wool, leather, energy, etc.?

Different kinds of livestock have different nutrient requirements. This is primarily due to differences in their digestive systems. Digestive systems are divided into two kinds: non-ruminant digestive system, sometimes called the simple digestive system; and the ruminant digestive system.

In order to understand that all kinds of livestock cannot utilize the same kinds and amount of feed, it is necessary to become acquainted with the digestive systems of animal for which the feed dealer supplies the necessary supplemental feed.

Assignment:

1. Read the references listed below.
2. Answer the questions listed in the question manual and turn in this assignment by ________________.

References:

A. Bundy and Diggins, *Livestock and Poultry Production*, pp. 31-35.
B. Morrison, *Feeds and Feeding*, pp. 17-27.
C. Ralston Purina Co., *Animal and Poultry Nutrition*, pp. 27-29.

Movie:

The Rumen Story: 26 min. color
How the digestive systems of dairy and beef cattle and sheep differ from non-ruminants: a detailed study and explanation of rumen digestion.

Suggested Teaching-Learning Activities

1. Visit the local freezer locker plant and have the manager or butcher show you the different parts of the digestive system of a beef animal and a hog.

2. Visit the local veterinarian to study pictures or models of parts of the digestive system.

3. Contact the Biological Science Department to study a plastic model of a human being. The human being has a simple stomach very much like that of a hog.

ED035773

STUDENT WORKSHEETS

Agricultural Supply, Sales, and Service Occupations

General Information

Part I

(Supplement to Publication No. 5)

VT010344

Assignment
Worksheet No. 1

BASIC ECONOMICS OF LIVESTOCK FEEDING AND THE LIVESTOCK INDUSTRY

True-False

Directions: The following statements are either true or false. If the statement is true, draw a circle around the letter "T". If it is false, draw a circle around the letter "F".

T F 1. Stockmen should take advantage of price changes in feed to secure an economical ration.

T F 2. Generally feeds that are low in protein cost more than feeds that are high in protein.

T F 3. The cost of grinding grain should be added to the cost of the grain when calculating cost of feed.

T F 4. It may be more profitable to feed only a small amount of concentrates when roughage is very cheap.

T F 5. Dairy cows have often gone off feed when fed very small amounts of roughage.

T F 6. Grains are generally higher in price at harvest time than at any other time of year.

T F 7. Dairymen producing market milk on high priced land near large cities will often buy most of their roughage and concentrates.

T F 8. Swine ranks above dairy cows in efficiency of converting digestible nutrients to human food.

T F 9. Poultry and swine are direct competitors with man for food since in this country they eat chiefly grain.

T F 10. Beef cattle rank above all other farm animals in efficiency of converting feed to human food.

ED035773

TEACHERS KEY

Agricultural Supply, Sales, and Service Occupations

General Information

Part I

App C Pt 3

(Supplement to Publication No. 5)

VT010311

Teachers Key
Assignment
Worksheet No. 1

BASIC ECONOMICS OF LIVESTOCK FEEDING AND THE LIVESTOCK INDUSTRY

True-False

1.	T	B-148
2.	F	B-149
3.	T	B-150
4.	T	B-154
5.	T	B-156
6.	F	B-156
7.	T	B-156
8.	F	B-158
9.	T	B-158
10.	F	B-158

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ED035773

AGRICULTURAL SUPPLY, SALES, AND SERVICE OCCUPATIONS

Feed -- Sales and Service Occupations

Part II

James T. Horner

M. Garfield McCreight

Publication No. 6

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

VT010311

This publication was prepared in furtherance of a project supported by a grant from the U. S. Department of Health, Education, and Welfare, Office of Education, entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming." The project was initiated by the Department of Agricultural Education of the University of Nebraska, and has been designated DAVR Project No. 001-65, and Contract No. OE-05-85-020.

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FEED SALES, SUPPLY AND SERVICE OCCUPATIONS

Introduction

The livestock industry in the United States is large. It utilizes vast quantities of feed which is a major cost in livestock production ranging from 50% of the cost of dairy production to 85% of the cost of beef production. People in this country have a very high standard of living. They consume large quantities of meat, milk, and eggs, and are large users of byproducts of the livestock industry. The feed industry can help to maintain this standard of living by being of valuable service to the livestock industry. Such service can be given by persons who have an understanding of and develop the abilities and skills mentioned below.

Feed sales and services involve such functions as: selling feed, delivering feed, processing feed, advising livestock feeders, interpreting feed analysis, etc. It involves the handling of feed grains such as corn, oats, barley, milo, etc.; protein concentrates such as: soybean oil meal, meat scraps, cottonseed meal, pillets or cake; minerals such as salt, bone meal; and commercial mineral mixtures. Special additives such as vitamins and antibiotics need to be considered. Some livestock feeders purchase and feed a complete ration, i.e., one that has all of the necessary ingredients for maintenance and production.

You will need to know a great deal about the retail feed business in order to serve well the customers of this type of business. The development of the following understandings, abilities, and skills are very essential:

1. To understand the basic economics of feeding
2. To understand basic animal nutrition
3. To be familiar with the value of various feeds
4. To be able to balance rations
5. To know how feeds are prepared
6. To become acquainted with the methods and trends in merchandising feed
7. To be familiar with the regulations in labeling and using feed
8. To become aware of the precautions in the use of special feed additives

Mastery of the material contained in this publication should enable you to make a satisfactory entry into this occupation.

Feed Sales, Supply and Service Occupations

Competencies to be Developed

Abilities To develop the ability to:		Assign. No.	Understandings To develop the understanding of:	
			Basic Economics of Livestock Feeding	
1	Quote feed prices to customers	1	1	Feed prices in general
		1	2	Relationship of feed prices to profit
		1	3	Efficiency of production by different classes of livestock
		1	4	Outlook for meat consumption
		1	5	Value of livestock in Nebraska
		1	6	How states rank in livestock population
			Structure of Function of Digestive System	
		2	7	Physical makeup of the digestive systems of farm animals
		2	8	Functions of the different digestive organs
			Fundamentals of Animal Nutrition	
2	Advise customers concerning animal needs for carbohydrates, fats and proteins	3	9	Kinds of nutrients needed for livestock production
		3	10	Functions of nutrients
		3	11	Sources of nutrients

	Abilities To develop the ability to:	Assign. No.		Understandings To develop the understanding of:
	Feed Additives			
3	Advise on purposes of feed additives	4	12	Kinds of feed additives
4	Advise on problems	4	13	Dangers from usage abuses of feed additives
5	How to use premixes	4	14	Purpose of premixes
	Classification of Feed Stuffs			
6	Recognize roughages that are high and low in fiber	5	15	Classes of feed
			16	Kinds of grains
7	Recognize concentrates that are low and high in protein	5	17	Kinds of roughages
			18	Kinds of protein feeds
8	Recognize animal products used in the feeding industry	5	19	Quality of roughages
			20	Quality of protein
9	Recognize common feeds and their substitutes	5	21	Sources of vitamins
			22	Sources of minerals
	Feed Analysis and Digestibility			
10	To interpret and use feed analysis tables	6	23	The relative value of the different nutrient constituents in common roughages, feed grains, and protein concentrates
11	Ability to evaluate roughages, pasture and grains	6		
			24	Feeds that are high in energy
12	Interpret feed analysis	6		
			25	Feeds that are high in protein
13	Recommend specific rations	6		

Abilities To develop the ability to:		Assign. No.	Understandings To develop the understanding of:	
		Processing Feeds		
		7	26	The different processes in preparing all feeds for livestock
		7	27	The value of the different methods of processing feeds
		7	28	Reasons for processing
		Formulating Rations		
14	Formulate rations	8	29	Purposes for formulating rations
15	Interpret feeding standards	8	30	How to formulate rations
16	Recommend satisfactory supplements			
		Feeding Beef Cattle		
17	Formulate beef cattle rations	9	31	Nutrient requirements of different classes of beef cattle
18	Interpret feed analysis	9	32	Relative value of roughages, pastures, concentrates
19	Interpret feeding standards	9	33	Feeding practices used in the community
		Swine Feeding		
20	Formulate swine rations	10	34	Nutrient requirements for swine
21	Interpret feed analysis	10	35	Feeding practices used in the community
22	Interpret feeding standards	10	36	Mineral requirements

Abilities To develop the ability to:	Assign. No.	Understanding To develop the understanding of:
Feeding Dairy Cattle		
23 Interpret feeding standards	11	37 Nutrient requirements for dairy cattle
24 Interpret feed analysis	11	38 Feeding practices used in the community
25 Formulate dairy rations	11	39 Mineral requirements
Feeding Sheep		
26 Formulate rations	12	40 Nutrient requirements for sheep
27 Interpret feed analysis	12	41 Feeding practices used in the community
28 Formulate dairy rations	12	42 Mineral requirements
Poultry Feeding		
29 Interpret poultry feed formulas	13	43 Nutrient requirements of poultry
30 Recommend formulations for different classes of poultry i.e., layers, broilers, chicks, poults, etc.	13	44 Feeding practices used in the community
	13	45 Mineral requirements

Abilities: To develop the ability to	Assign. No.	Understandings: To develop the understanding of
Selection, Calibration, and Maintenance of Fertilizer Equipment		
30. Calibrate fertilizer application equipment.	8	31. Principles and methods of fertilizer application.
31. Select various fertilizer application equipment.	8	32. Methods of calibrating of adjusting fertilizer applicators.
32. Advise customers on proper maintenance procedures.	8	33. Methods of lengthening fertilizer application equipment life.
33. Identify and evaluate fertilizer application equipment.	8	34. Basic design factors to consider for fertilizer applicators.
		35. The chief enemies of fertilizer applicator equipment life.
Merchandising Fertilizer Effectively		
34. Maintain good company-customer relationships.	9	36. Satisfying customer needs.
35. Maintain old and obtain new customers.	9	37. Customer resistance to increased fertilizer purchases.
36. Develop effective advertising programs.	9	38. Results of various advertising techniques.
37. Meet customer demands and needs.	9	39. Personnel attitude on customer sales.
38. Successfully sell fertilizer products.	9	40. Methods of effective advertising and promotion.

Assignment
No. 1

THE ECONOMIC VALUE OF THE USE OF FERTILIZER IN CROP PRODUCTION

Fertilizer is one of the most economical purchases of all agricultural supplies used by a farm or ranch. Fertilizer prices have increased only 15% in the past twenty-five years while prices of all other agricultural supplies have risen much more rapidly.

The economic importance of fertilizer is rapidly becoming understood by today's farmers and landowners. Proper use of fertilizers is of crucial importance in an age of narrow farm income production ratios. What fertilizer applications would you recommend for a farmer to receive maximum profits? What factors would you need to consider to make proper recommendations to a farmer about his fertilizer needs? You will need to be able to answer these types of problems to successfully handle your job.

Assignment:

1. Read the following material and references.
2. Complete the suggested learning activities.
3. Answer the questions concerning this assignment in the Question Manual and turn in this assignment when completed. (Suggested time allotment for this assignment ______ to ______ hours.)

References:

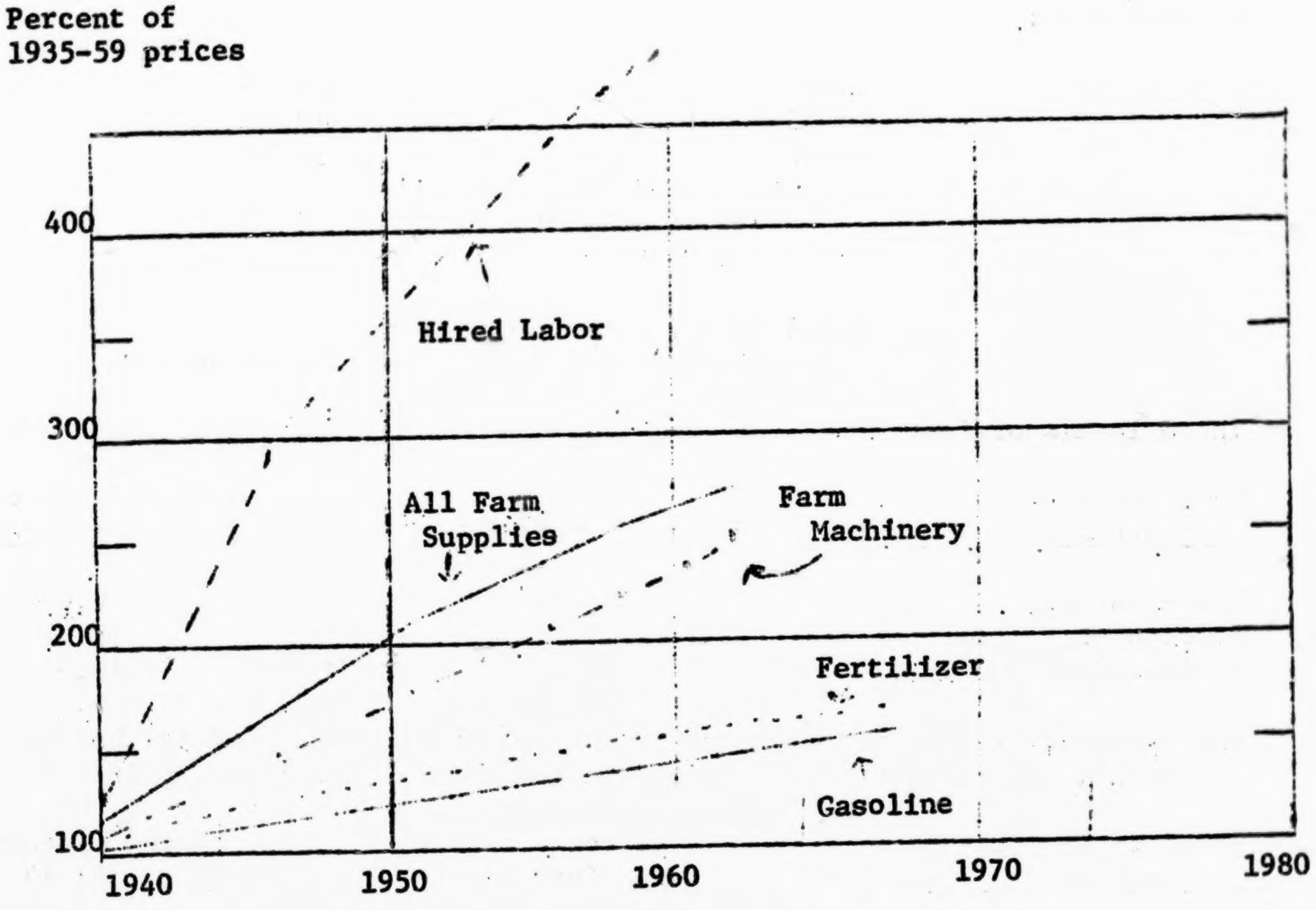
A. National Plant Food Institute, Our Land and Its Care, Fourth edition, 1962. pp. 63-67.

B. McVickar, Using Commercial Fertilizers, Second edition, 1961. pp. 237-249.

X. The following material adapted for use in this assignment from Fertilizers, Sales and Service: The Center for Research and Leadership Development in Vocational and Technical Education, Columbus, Ohio.

Fertilizer is one of the best buys of all the agricultural supplies a farmer or rancher needs. Whereas prices of all agricultural supplies have risen over 125 percent, commercial fertilizer prices have increased only about 15 percent in the past twenty-five years. This is shown on the following chart.

PRICES PAID BY FARMERS



Source: USDA, Washington, D.C.

Farmers and homeowners now are more aware of the economic value of fertilizer. The fertilizer industry, state land-grant colleges, and the U.S. Department of Agriculture have made considerable progress in educating the buyer in the proper use of fertilizer and its value in crop, lawn, and garden production.

The economics of crop production should indicate the value of proper fertilization but one should first understand fixed costs and variable costs. Fixed costs are those that cannot be reduced or eliminated. The yearly cost of land ownership or rental is always a fixed cost. Other costs are variable until the operation or purchase in made, then they become fixed costs. An example of a variable cost is plowing. Money may or may not be spent to plow the land, but, after plowing, the expense is fixed and must be paid, whether or not a crop is planted.

All costs listed in the example below are fixed. These are realistic figures taken from field trials with corn in Ohio. The fixed costs of growing an acre of corn were:

Land	$ 9.50
Machinery	12.00
Labor	14.00
Supplies (seed, weed spray, and others)	8.00
Miscellaneous costs	1.50
Total costs, except for fertilizer	$45.00 an acre

Three levels of fertilizer were applied with the following costs and results.

Level of application per acre	Cost of fertilizer	Bushels of corn per acre
Low--100 lbs.	$ 4.00	45.0
Average--228 lbs.	9.12	51.3
Recommended--700 lbs.	28.00	76.5

The economic results are apparent in the following tables. Note that at $1.00 per bushel, fertilizer levels below the recommended level result in a net loss.

Level of application per acre	Total costs, fixed plus fertilizer	Value of corn at		
		$1.00	$1.15	$1.30
Low	$49.00	$45.00	$51.75	$58.50
Average	$54.12	$51.30	$59.00	$66.69
Recommended	$73.00	$76.50	$87.98	$99.45

Level of application per acre	Profit or loss per acre		
	$1.00	$1.15	$1.30
Low	- $4.00	$2.75	$ 9.50
Average	- $2.82	$4.88	$12.57
Recommended	$3.50	$14.98	$26.45

Three factors relate to the profit from growing a crop.

1. The total costs of production
2. The level of production (bushels of corn)
3. The market value of the product (corn)

The recommended level of fertilization can best be determined by accurate soil fertility tests and carefully controlled test plots conducted in the farmer's fields.

Limited capital frequently prevents the application of fertilizer at recommended levels. Research shows that return per dollar invested in fertilizer is higher at low fertilization than at high, but high fertilization brings the greatest total return per acre per dollar spent.

Nationwide studies show that crop producers are using less than forty percent of the recommended levels of fertilizer. This is an indication of the sales potential at the retail level and the service that can be provided to crop producers to enable them to increase their production and profit.

Suggested Learning Activities

1. Study the community and locate the concerns that handle fertilizers to determine the types and volume handled.
2. Determine how much crop production must increase by the year 2000 to feed our expected population.
3. Interview a farmer to determine the amount of fertilizer used per acre and his expected use of fertilizer in the future.
4. Develop comparisons of yields and production costs for local crops.
5. Review state college of agriculture publications showing the results of fertilization demonstrations.
6. Visit a local fertilization demonstration plot if available.
7. Interview resource person from a local fertilizer distributorship to discuss the actual examples of crop production economics based on cases in the community.

Suggested Instructional Materials and References

Instructional materials

1. Data collected on the results of local fertilization demonstrations.
2. Slides or films, such as Profit in Forage and Pasture, showing crop yield response to fertilization.

References:

1. Our Land and Its Care, pp. 63-67.
2. Using Commercial Fertilizers, pp. 237-249.

Assignment
No. 2

THE AVAILABILITY OF PLANT NUTRIENTS AND EFFECTS OF ENVIRONMENTAL CONDITIONS ON PLANT GROWTH

Persons interested in working in the fertilizer sales and service industry not only need to understand how plants use fertilizer, but also should have an understanding of how some other environmental conditions may affect plant growth and reproduction. Amount of rainfall, temperature, and weeds are just a few examples of environmental conditions which affect plant growth and reproduction.

Factors such as these mentioned above must be taken into consideration when planning fertilizer programs with a farmer or when observing a field during the growing season or its yield after harvest. A good understanding of such environmental conditions and their effects is essential to successfully meet some of the problems that will arise for a fertilizer sales and service employee to answer.

The following assignment will explain some of the environmental effects more fully and how they affect plant growth and reproduction.

Assignment:

1. Read the following materials and references.
2. Complete the suggested learning activities.
3. Answer the questions concerning this assignment in the Question Manual and turn in when completed.

References:

A. National Plant Food Institute, Our Land and Its Care, Fourth Edition, 1962. pp. 22-39.

B. McVickar, Using Commercial Fertilizers, Second Edition, 1961. pp. 1-5.

D. National Plant Food Institute, The Fertilizer Handbook, 1963. pp. 39-57.

X. The following material adapted for use in the assignment from Fertilizer, Sales and Service, The Center for Research and Leadership Development in Vocational and Technical Education, Columbus, Ohio.

A person interested in employment in sales and service involving fertilizer materials should concern himself with how plants use fertilizer, be aware of the effects of other environmental conditions on the growth and reproduction of plants.

ED035773

STUDENT WORKSHEETS

Agricultural Supply, Sales, and Service Occupations

Feed Sales and Service Occupations

Part II

(Supplement to Publication No. 6)

VT010311

Assignment
Worksheet No. 1

THE ECONOMIC VALUE OF THE USE OF FERTILIZER IN CROP PRODUCTION

Multiple Choice

Directions: In the space at the left of each statement, write the letter of the item which will provide the correct answer to complete the statement.

_____ 1. Farm output per acre has increased by what percent in the last 20 years?
   a. 25%
   b. 50%
   c. 75%
   d. 100%

_____ 2. In an area where the soil is predominantly low in fertility which of the following statements is more likely to be correct?
   a. High land value per acre and high value of farm products sold per farm.
   b. Low land value per acre and high value of farm products sold per farm.
   c. High land value per acre and low value of farm products sold per farm.
   d. Low land value per acre and low value of farm products sold per farm.

_____ 3. Which of the following statements is correct?
   a. The acreage in cropland has increased considerably in the last 20 years.
   b. Differences of soil fertility is not reflected in the value of land per acre.
   c. Rich, fertile soils will support a more prosperous economic level.
   d. We basically depend on the natural fertility of the land for crop production.

_____ 4. Most of the items in the cost of crop production:
   a. are higher at low yields.
   b. are lower at high yields.
   c. are high at all times.
   d. are the same regardless of large or small yields.

_____ 5. Fixed costs are:
   a. costs that must be paid regardless of production.
   b. costs such as taxes, cash rent, depreciation.
   c. costs which decrease per unit as yield increases.
   d. all of the above.

_____ 6. High fertilization rates generally:
   a. bring the largest return per acre per dollar spent.
   b. bring the largest return per bushel per dollar spent.
   c. decrease total production costs.
   d. decrease total production output.

_____ 7. Return per dollar invested in fertilizer is:
   a. lower at low fertilization rates.
   b. higher at low fertilization rates.
   c. higher at high fertilization rates.
   d. the same regardless of fertilization rates.

_____ 8. Compared to the costs of hired labor and farm machinery, fertilizer costs:
   a. have increased more rapidly.
   b. have remained the same.
   c. have increased less rapidly.
   d. have decreased in price.

_____ 9. According to the research material presented, which application level of fertilization produced the most profit?
   a. low application
   b. average application
   c. recommended application
   d. above recommended application

_____ 10. Which of the following factors will not affect the profit received from raising a crop?
   a. the total costs of production
   b. the level of production
   c. the market value of the product
   d. the total residue remaining after harvest

Completion

Directions: Fill in the blank(s) in each statement with the word(s) required to complete the sentence correctly.

1. Farm output per acre has increased _______ percent in the last 20 years.

2. Highly fertile farms are generally worth (more, less) _________ per acre and produce _________ than farms low in fertility.

3. Today, we can no longer depend on ________ fertility to meet the plant nutrient needs of the soil.

4. ___________ capital frequently prevents the application of fertilizer at recommended levels.

5. Costs which must be paid whether or not a crop is produced are ________ costs.

6. Costs that may or may not be spent may be classified as ______ costs.

7. Highest income per acre is usually received by applying the ________ levels of fertilizer.

8. If the value of a crop increases, it would probably be profitable to (increase, decrease) ______ the level of fertilizer application.

9. Fertilizer prices have increased (more, less) _______ than the average prices of other farm supplies.

10. Total costs of production will (increase, decrease) _________ as higher levels of fertilization are applied.

Listing

Directions: List the items called for in each of the following. Select your answers carefully.

1. List three factors that relate to the profit from growing a crop.
   a.
   b.
   c.

2. What are the two types of costs with which a farmer is faced.
   a.
   b.

3. The market price for a crop includes:
   a.
   b.
   c.

4. Give two examples of fixed costs.
   a.
   b.

5. Give two examples of variable costs.
   a.
   b.

ED035773

TEACHERS KEY

Agricultural Supply, Sales and Service Occupations

Feed Sales and Service Occupation

Part II

(Supplement to Publication No. 6)

Agric Occ

Teachers Key
Assignment
Worksheet No. 1

THE ECONOMIC VALUE OF THE USE OF FERTILIZER IN CROP PRODUCTION

Multiple Choice

1. b
2. d
3. c
4. d
5. d
6. a
7. b
8. c
9. c
10. d

Completion

1. 50
2. more, more
3. natural
4. limited
5. fixed
6. variable
7. recommended
8. increase
9. less
10. increase

Listing

1. a. Total costs of production
   b. Level of production
   c. Market value of the product

2. a. fixed
   b. variable

3. a. harvest costs
   b. storage costs
   c. transportation costs

4. a. depreciation
   b. taxes

5. a. plowing
   b. seed

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AGRICULTURAL SUPPLY, SALES, AND SERVICE OCCUPATIONS

Fertilizer Sales and Service Occupations

Part III

James T. Horner

C. Edward Henderson

James J. Albracht

Publication No. 7

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

VT010311

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FERTILIZE--SALES AND SERVICE

Major Objective

To develop the understandings and abilities needed for initial employment as an"inside salesman" in the agricultural supply business, which includes fertilizer among its sales and services.

Introduction

The commercial fertilizer industry has shown a tremendous growth in both size and importance in the nation in recent years. During the ;960-61 fertilizer year alone there were 25 million tons of commercial fertilizer consumed. This was more than 300% of the entire commercial fertilizer production in the United States prior to World War II.

Commercial fertilizer application has been an important reason for the steady increase in crop production. More and more farmers are using fertilizers today, and the farmers have increased their yields accordingly. Proper application of the correct fertilizers is of growing importance for the farmer to receive still higher yields.

Increasing the use of fertilizers and the resultant higher productive yields demands that more nutrients be applied to the soil to maintain its physical condition and productive capacity. Higher crop residues in the soil require that some additional nutrients also be added to aid in the decomposition of such additional crop residues.

Twenty percent of the agricultural production in the United States--equal to all the crop production in the states of Iowa, New Jersey, Connecticut, Massachusetts, and Delaware--is credited to the use of fertilizer. The cost of cultivating this land would be more than three times the annual expenditure for fertilizer. Without fertilizer, this would be a nation of food scarcity instead of a land of plenty. This abundant crop production permits us to feed a livestock industry that provides the milk, meat, and eggs which supplies the American people a luxury diet second to none. To maintain this enviable position, however, crop production must keep pace with the exploding population. This means that the fertilizer industry needs to expand to supply the necessary plant food. The fertilizer industry has quadrupled its production in the past twenty-five years (1940-1965) and is expected to double it again by 1985 at an increase of five percent a year.

Since the future in the fertilizer industry is promising, so also is that in retail service and sales of fertilizer. How does a young man enter this area of employment? Below are some of the understandings, abilities, and skills needed by employees in businesses selling fertilizers.

1. To appreciate the economic value of fertilizer in crop production.
2. To understand how plant growth is related to the availability of plant nutrients and other environmental conditions.
3. To understand how fertilization is affected by the basic physical, chemical, and biological properties of soil.
4. To understand the characteristics of commonly used fertilizer materials.
5. To interpret fertilizer formulas.
6. To understand the methods used to determine the fertility needs of soils and to develop the ability to take soil samples.
7. To interpret a soil test report.
8. To make fertilizer recommendations.
9. To understand the basic principles of fertilizer manufacture and plant operations.
10. To understand how to advise customers about the selection, calibration and maintenance of fertilizer equipment.
11. To merchanidse fertilizer effectively.
12. To understand the importance of the fertilizer industry and its future trends.

The commercial fertilizer industry has become a very broad and complex area in the agricultural field today. The farmer has to rely on other individuals to supply him with assistance in planning his fertilizer programs or meeting any of his fertilizer problems. As a worker in the sales and service phase of the fertilizer industry you can be valuable in supplying prospective customers with necessary information. Proper sales and service insures satisfied customers, increases the sales volume of the retail fertilizer outlet, and should result in advancement for the employee. A thorough knowledge of your product is essential to your success.

To be an effective employee at any level of employment in businesses handling fertilizers, one must have a working knowledge of these understandings and abilities. A young man's chances fo· employment in fertilizer sales and services and his opportunity for advancement are based on his ability to sell fertilizer. Customers buy primarily because they want such benefits as higher yields, reduced costs, saved labor, and early maturity. The sales employee needs to appeal to the basic needs of prospective customers in order to show how the use of fertilizers will be beneficial. Proper sales and service insures satisfied customers, increases the sales volume of the retail fertilizer outlet, and should result in advancement for the employee.

ANALYSIS OF PART III FERTILIZER - SALES AND SERVICE

Abilities: To develop the ability to	Assign. No.	Understandings: To develop the understanding of
1. Determine most profitable levels of fertilizer application.	1	1. Factors to consider that determine correct fertilizer levels.
2. Evaluate the economic importance of fertilizer.	1	2. Methods used to determine fertilizer economic importance.
3. Determine economic costs of production.	1	3. Criteria to consider in determining production costs.
The Availability of Plant Nutrients and Effects of Environmental Conditions on Plant Growth		
4. Recognize essential primary secondary and micro plant nutrients.	2	4. Functions of primary, secondary, and trace elements on plant growth.
5. Identify physical symptoms of nutrient deficiencies.	2	5. Environmental factors on crop production.
6. Recognize "hidden hunger" in crop production.	2	6. Rates, dates and depth of planting crops on fertilizer requirements.
7. Correlate soil type with possible micro-nutrient deficiencies.	2	7. The relationship between various plant nutrients and their combined effect on crop production.
		8. The physiological results of nutrients on plant growth.
How Fertilization is Affected by Basic Physical, Chemical, and Biological Properties of Soils		
8. Recommend correct liming material to customers.	3	9. Soil texture effect on fertilizer use.
9. Grade lime materials according to their efficiencies.	3	10. Amounts of fertilizer available in the soil.
10. Determine the proper amount of lime to apply under various soil conditions.	3	11. Microorganism activity and effects on soil activity.
11. Identify various liming materials.	3	12. Environmental factors that affect soil organism activity.
		13. How soil pH affects plant response to fertilizers.
	3	14. Results of lime use.
Characteristics of Commonly Used Fertilizer Materials		
12. Identify various fertilizers in relation to available nutrient content.	4	15. Safety precuations necessary when handling fertilizers.

Abilities: To develop the ability to	Assign. No.	Understandings: To develop the understanding of
13. Recommend efficient application methods.	4	16. The chemical characteristics of fertilizers.
14. Advise customers on correct handling and storage of fertilizers.	4 4	17. Water content effect on fertilizers.
15. Explain advantages and disadvantages of different types of fertilizers.		18. Fertilizer analysis in relation to fertilizer physical characteristics

Interpreting Fertilizer Formula

16. Evaluate fertilizer effectiveness.	5	19. How to interpret fertilizer.
17. Convert total amounts to available amounts of elements present in a fertilizer.	5 5	20. Factors to consider when developing a fertilizer formula.
18. Develop actual fertilizer formulas.	5	21. State regulations on fertilizer labeling.
19. Determine or recognize economical fertilizer formulas	5	

Methods Used to Determine Fertility Needs of Soils

20. Take good soil samples.	6	22. Conditions that affect soil sample test results.
21. Organize fertilizer demonstration plots.	6 6	23. The need for nutrient testing devices.
22. Conduct plant tissue tests.	6	24. Methods used in developing fertilizer test plots.
23. Make economic comparisons between demonstration plots.	6	

Soil Test Reports Interpretation And Making Fertilizer Recommendations

24. Interpret soil test reports.	7	25. Methods used in reporting soil test results.
25. Make fertilizer program recommendations.	7 7	26. Soil texture relationship to soil nutrient needs.
26. Identify soils needs in relation to soil texture.	7 7	27. Organic matter importance in soil tests.
27. Determine type of fertilizer program desirable.	7 7	28. The interrelationship of soil pH and soil nutrient needs.
28. Recommend correct time and placement of fertilizers to customers.	7 7 7	29. Tests for soluble salt content.
29. Identify common fertilizer ratios for various crops.	7 7	30. Crop needs in relation to soil test results.

ABILITIES: To develop the ability to	Assign. No.	UNDERSTANDINGS: To develop the understanding of
24. Advise customers on proper materials for insect and disease control	6	26. How supply services differ in different firms
25. Advise customers on proper harvesting procedures	6	27. What services your firm can offer
26. Recommend operational procedures for customer use of special equipment	6	28. The strong and weak points of products offered
27. Find product information quickly from catalogs and other sources	7	29. Any special equipment your firm has for rental or loan
28. Satisfy customer needs with proper materials and products	7	30. The kinds of information that is available concerning products in catalogs
29. Give proper advice to customers related to plant production	7	31. What to do when an item is not available in the store
30. Fulfill customer needs concerning home beautification	7	32. Plant production
31. Know costs of crop production materials	7	33. The basic economics of home beautification
32. Know cost of garden production materials	7	34. The basic economics of crop production
	7	35. The basic economics of garden production

Assignment
No. 1

CROP SEEDS

Millions of dollars are being spent annually to produce better seed. Outstanding crop varieties are imported from other countries, and many of their characteristics are incorporated into the genetic makeup of our adapted seeds.

The cheapest means of weed control is to plant weed free seeds. Much painstaking effort goes into the annual production of weed free seeds to be used by farmers. The farmer depends on reputable dealers and sales workers to provide him with high quality seed free of weeds, inert matter, and varietal mixtures.

The state departments of agriculture and state agricultural colleges maintain seed testing facilities to safeguard the quality of our agricultural seeds. Certified seed growers spend much extra time and money in the production of quality seed. Commercial companies spend great sums of money doing research to discover new ways of protecting the seed, and in helping the plant produce greater yields by enriching it, and by protecting it from insects and diseases. The seed handler is an important link between industry and the farmer.

Assignment:

1. Read the references listed below.
2. Complete the suggested learning activities listed below the references.
3. Answer the questions concerning this assignment in the Question Manual and turn in when completed. (Suggested time allotment for this assignment: 5 to 8 hours.)

References:

A. The Midwest Farm Handbook, Iowa State College Press, Ames, Iowa, Fourth Edition, 1957, pp. 158-181; 241-262.

B. E. C. 178, Crop Varieties for Nebraska--1965, Agricultural Extension Service, College of Agriculture and Home Economics, Lincoln, Nebraska, February 1965.

Suggested Learning Activities

1. With the aid of the seed tags discuss the origin and quality of several lots of seed that are for sale at your place of employment.
2. Describe the seed treatment materials, methods, and facilities that are used in treating seed at your place of employment.

3. Make diagrams of the most troublesome weed seeds that affect the crop seeds in your community.

4. Prepare a newspaper advertisement of one of the crop varieties that is for sale at your place of employment.

5. Write for copies of the Nebraska Certified Seed Handbook and the Nebraska Seed Law pamphlet.

6. List the varieties of wheat, oats, barley, soybeans, grain and forage sorghum, alfalfa, sweet clover, corn and other crops that are recommended for your area of the state. Refer to c.c. 178 "Crop Varieties for Nebraska--1965."

Assignment
No. 2

GARDEN SEEDS

A good garden is the result of careful planning and much work. The benefits from a garden can be enjoyed throughout the year. Many people enjoy working outside, and the work in their garden fills their spare moments with satisfying, enjoyable, and productive activity.

The garden is no better than the seed that is planted. Numerous companies produce garden seed not all of which is adapted to a particular area. More and more gardeners come to depend on reputable garden seed dealers and sales workers to supply them with good, viable, adapted garden seeds. The sales, supply, and serviceman's job becomes increasingly important also because more gardeners seek his services in the selection of the many other commercial supplies that are on the market to assist him in having a more enjoyable and profitable experience with his garden operation.

Assignment:

1. Read the references listed below.
2. Complete the suggested learning activities listed below the references.
3. Answer the questions concerning this assignment in the Question Manual and turn in when completed. (Suggested time for this assignment: 4 to 6 hours.)

References:

A. E. C. 1274, Garden Vegetables, Agricultural Extension Service, College of Agriculture and Home Economics, Lincoln, Nebraska, 1959.

Suggested Learning Activities:

1. Draw up a plan of a garden which would satisfy the needs of an average family.
2. Make a list of the garden seed varieties that are sold at your place of employment, and compare this list with the list of recommended vegetable varieties on pages 6 and 7 in the reference E.C. 1274. (Not all hybrid vegetable varieties are included in E. C. 1274.)
3. Make a display or poster describing one of the garden products or services which is available at your place of employment.
4. Make a diagram showing the operation of one of the pieces of garden equipment that can be purchased or borrowed from your place of employment and show in detail how this piece of equipment is operated.

STUDENT WORKSHEETS

ED035773

Agricultural Supply, Sales, and Service Occupations

Fertilizer Sales and Service Occupations

Part III

(Supplement to Publication No. 7)

VT010341

Assignment
Worksheet No. 1

CROP SEEDS

True - False

Directions: The following statements are either true or false. If the statement is true, draw a circle around the letter "T". If it is false, draw a circle around the letter "F".

T F 1. The only certain way to determine the value of seed for planting is to have a reputable seed laboratory make a complete test before it is sown.

T F 2. State and Federal seed laws require that seed moving in state or interstate commerce be labeled as to quality.

T F 3. Seed tests can be performed only in State Government seed laboratories.

T F 4. The germination of new seed cannot be determined during the fall months.

T F 5. Seed should be submitted shortly after harvest if rapid service is desired.

T F 6. The larger the storage area, the greater the need for drawing a representative sample from many places.

T F 7. Regular envelopes are satisfactory for mailing in seed samples to be tested.

T F 8. Any seed that is offered for sale must have an official seed test.

T F 9. Seed offered for sale may not contain more than 1½% primary noxious weeds.

T F 10. A germination test must be taken within 15 months of the sale of the seed.

T F 11. Expected quality may be described as the percentage of pure, live seed necessary to give a satisfactory stand at seeding rates now recommended.

T F 12. The cheapest weed control is to plant weed-free crop seeds.

T F 13. The hedge bindweed seed is the same shape as the field bindweed seed, but the seed is smaller and of darker color.

T F 14. Perennial pepper grass is sometimes called white top or hoary cress.

T F 15. The dodder plant is a yellow leafless vine that grows as a parasite on legumes.

T F 16. Treated seed may be fed to livestock after it has been stored for 3 months or more.

T F 17. The slurry and liquid methods of chemical seed treatment do not require special treating equipment.

T F 18. The dust toxicity hazard is avoided with the slurry and liquid methods of soil treatment.

T F 19. The hot water and long water soak methods are commonly used for the control of loose smut in wheat and barley.

T F 20. It is very important to follow directions closely when working with chemical seed treaters.

T F 21. Soybeans deplete the soil for the crops following them.

T F 22. Soybeans, sorghums, and corn use the same seedbed preparations.

T F 23. Bacteria that form and inhabit the nodules on the roots of legumes can take nitrogen from the air and make it available to the plant.

T F 24. It is not desirable to innoculate legume seed in all cases.

T F 25. Temporary pastures are perennials that supplement permanent pastures.

Completion

Directions: Fill in the blank(s) in each statement with the word(s) required to complete the sentence correctly.

1. Seeds which are temporarily impermeable to water and do not sprout in the seed laboratory are called________________.

2. The test that simulates unfavorable cold and wet conditions which are quite often present in Midwest states early in the spring is called the ________________.

3. Seed lots of cereals, clovers, and alfalfa should contain over _______ pure seed; bromegrass over __________; and bluegrass over _______ to be considered good seed.

4. Total common weed seeds should not exceed ________ of the total sample.

5. The best single index of seed quality is the ________________ percentage.

6. The pure live seed percentage is obtained by multiplying the ______ percentage by the ___________ percentage.

7. If the pure seed percentage is 90 and the germination percentage is 60, then the pure live seed percentage is_________.

8. The cost per pound of pure live seed may be determined by dividing the price per pound by the __________________.

9. If lot A seed is 98% pure with a germination of 90% and a cost of 40¢ per pound, the price per pound of pure live seed is_________.

10. If lot B seed is 99% pure with a germination of 70%, and a cost of 35¢ per pound, the price per pound of pure live seed is___________.

11. The use of good seed is the essential foundation for a good _______ __________program.

12. The ________, ___________, and the ___________ methods are the most commonly used in treating seed with chemicals.

13. Planting with __________________ is the most effective method of controlling loose smut in wheat and barley.

14. The greatest problem in using the hot water method for controlling loose smut in small grains is that it often adversely affects the __________________ of the seeds.

15. Some seed companies are adding __________ to seed disinfectants to help control insects which destroy seeds either in the soil or storage.

16. Soil innoculants should be used _________ the chemical disinfectant and not earlier than _______________ before planting.

17. If moisture and soil fertility are very good, the highest yields for corn probably will be obtained from stands of ___________ stalks to the acre at harvest time (4 to 5 stalks per 40" of row spaced 40 inches apart).

18. If soil and moisture conditions are only medium to good, then corn stands of ___________ stalks per acre at harvest time (3 to 4 stalks per 40" of row) are best.

19. In order to have the desired number of stalks at harvest time, it is necessary to plant about __________ more kernels per hill or acre than the number of stalks per hill or acre desired in the fall.

20. Soybean seeds should be planted about 1" apart in rows; this rate will require about __________ bushels of seed per acre in 21-inch rows and slightly less than _________ bushel in 40-inch rows.

21. Forage or sweet-stemmed sorghum varieties grown primarily for forage, silage, and syrup are commonly called____________.

22. Sorghum varieties grown for grain are often referred to as double dwarf or ________________.

23. Sorghum is usually planted ________________ later than the most desirable date for planting corn.

24. Oats are usually seeded at the rate of _________ bushels per acre.

25. Barley is generally seeded at the rate of ___________ per acre.

26. The sowing date for winter wheat is usually governed by the Hessian bly free date which occurs during the latter part of __________.

27. Wheat is usually seeded at the rate of _______ pecks to the acre.

28. Alfalfa is usually seeded at the rate of _________ pounds per acre of pure stands, and __________ pounds alfalfa, and ___________ pounds of bromegrass for mixed stands.

29. Grasses may be established in _________________ or ____________.

30. Sudangrass is planted after corn, at the rate of __________ pounds of seed per acre when broadcast and _________ pounds of seed per acre when planted in rows.

31. Sugar beets are usually planted at the rate of _______ pounds of seed per acre.

Multiple Choice

Directions: In the space at the left of each statement, write the letter of the item which will provide the correct answer to complete the statement.

_____ 1. Leafy spurge seeds may be identified by their:

a. More or less oblong shape, an eighth of an inch in length, slightly narrowed at one end, dull brown in color except for the collar at the top which tends to be yellowish.

- b. Football shape, about an eighth of an inch in length, with a smooth grayish white marbled appearance.
- c. Nearly smooth reddish-brown color, one eighth inch in length, somewhat football shaped and slightly flattened with a furrow running down each of the sides to the narrow end.
- d. Orange section shape, one fourth of an inch in length, with a smokey gray color, and with a covering of small bumps or warts.

______ 2. Field bindweed seeds may be identified by their:
- a. Orange section shape of one fourth inch in length, with smokey gray color, and with a covering of small bumps or warts.
- b. Football shape, about an eighthof an inch in length, with a smooth grayish-white marbled appearance.
- c. Nearly smooth, reddish brown color, one eighth inch in length, somewhat football shaped and slightly flattened, with a furrow running down each of the sides to the narrow end.
- d. More or less oblong shape, an eighth of an inch in length, slightly narrowed at one end, dull brown in color except for the collar at the top which tends to be yellowish.

______ 3. The Russian knapweed seeds may be identified by their:
- a. Football shape, about an eighth of an inch in length, with a smooth grayish-white marbled appearance.
- b. Nearly smooth reddish-brown color, one eighth of an inch in length, somewhat football shaped and slightly flattened, with a furrow running down each of the sides to the narrow end.
- c. Orange section shape, one fourth of an inch in length, with a smokey gray color, and with a covering of small bumps or warts.
- d. Somewhat oblong to egg shape, one eighth of an inch in length, with a little point at the broad end; the surface is nearly smooth or with inconspicuous longitudinal angles or ridges, and by their generally light gray to cream color.

______ 4. Canada thistle seeds may be identified by their:
- a. Orange section shape, one fourth of an inch in length, with a smokey gray color, and with a covering of small bumps or warts.
- b. Somewhat oblong to egg shape, an eighth of an inch in length, with a little point at the broad end; the surface is nearly smooth with inconspicuous longitudinal angles or ridges, and by their generally light gray to cream color.

c. More or less oblong and nearly straight shape, an eighth of an inch in length slightly narrowed at one end, dull brown in color except for the collar at the top which tends to be yellowish.
d. Football shape, about an eighth of an inch in length, with a smooth grayish-white marbled appearance.

_____ 5. Hoary cress seeds may be identified by their:
a. Nearly smooth reddish-brown color, one eighth inch in length, somewhat football shaped and slightly flattened with a furrow running down each of the sides to the narrow end.
b. More or less oblong and nearly straight shape, an eighth of an inch in length slightly narrowed at one end, dull brown in color except for the collar at the top which tends to be yellowish.
c. Somewhat oblong to egg shape, an eighth of an inch in length, with a little point at the broad end; the surface is nearly smooth with inconspicuous longitudinal angles or ridges, and by their generally light gray to cream color.
d. Football shape, about an eighth of an inch in length, with a smooth grayish-white marbled appearance.

Listing

Directions: List the items called for in each of the following. Select your answers carefully.

1. List the name and address of the state seed laboratory:

____

____

____

____

2. List the procedure suggested for submitting seed samples to the seed testing laboratory:
a.
b.
c.
d.

3. List the formula for determining the adjusted seeding rate if the quality of the seed is considered:

4. The following expected qualities may be used for some of the common crop seeds in the Midwest:

Alfalfa__________ Lespedeza___________ Small grains_____

Red clover_______ Bromegrass__________ Soybeans__________

5. What would be the adjusted seeding rate for alfalfa with an expected quality of .83 and a recommended seeding rate of 10 lbs. per acre, if the seed used had a purity of .95 and a germination of 80%?

6. Give a description of the seed of a dodder plant:

a.
b.
c.

7. The purposes of seed treatment are to:

a.
b.

8. Liquid disinfectants are usually applied to seed by one of two general types of ready-mix treaters as follows:

a.
b.

9. While treating seed, the operator should exert care to:

a.
b.
c.

10. List the characteristics and uses of Ceresan M as a seed treatment:

11. List the characteristics and uses of Panogen 15 as a seed treatment:

____

____

____

____

12. List the characteristics and uses of Arasan 75 as a seed treatment:

____

____

____

____

13. List the characteristics and uses of Captan 75 seed treater:

____

____

____

____

14. A separate group of bacteria should be specified for each of the several groups of legumes. Legumes and innoculating bacteria can be classified into groups as follows:

a

b

c

d

e

f

g

h

15. List the requirements for certifying small grains and soybeans:

a

b

c

d

e

f

16. Unexpected forage shortages can be met most economically by the following temporary pastures:

a Cool season:______________________________

b Warm season______________________________

ED035773

TEACHERS KEY

Agricultural Supply, Sales, and Service Occupations
Fertilizer Sales and Service Occupations
Part III

(Supplement to Publication No. 7)

VT010311

Teachers Key
Assignment
Worksheet No. 1

CROP SEEDS

True-False

1.	T	A-241
2.	T	A-241
3.	F	A-242
4.	F	A-243
5.	T	A-243
6.	T	A-243
7.	F	A-243
8.	T	A-244
9.	F	A-244
10.	F	A-244
11.	T	A-246
12.	T	A-246
13.	F	A-250
14.	T	A-249
15.	T	A-256
16.	F	A-258
17.	F	A-258
18.	T	A-258
19.	F	A-259
20.	T	A-258
21.	F	A-159
22.	T	A-160
23.	T	A-170
24.	F	A-170
25.	F	A-181

Completion

1.	"hard seeds"	A-241
2.	cold test	A-241
3.	97%, 90%, 85%	A-245
4.	.5%	A-245
5.	pure live seed	A-245
6.	pure seed, germination	A_245
7.	54	A-245
8.	Purity x germination	A-245
9.	45¢	A-245
10.	58¢	A-245
11.	weed control	A-246
12.	dust, slurry, liquid	A-258
13.	certified seed	A-259
14.	germination	A-259
15.	insecticides	A-260
16.	after, two hours	A-262
17.	16,000 to 20,000	A-158
18.	12,000 to 16,000	A-158
19.	one-fourth (25%)	A-158
20.	1 to 1½, one	A-160
21.	sorgs	A-160
22.	combine types	A-160
23.	10 days to 2 weeks	A-161
24.	2 to 2½	A-162
25.	3 bushels	A-163
26.	September	A-165
27.	5	A-165
28.	8-12, 6-8, 4-6	A-166,167
29.	early spring, late summer	A-170
30.	15 to 20, 5	A-173
31.	15	A-173

Multiple Choice

1. b Football shape, about an eighth of an inch in length, with a smooth grayish-white marbled appearance. A-249

2. a Orange section shape of one fourth inch in length, with smokey gray color, and with a covering of small bumps or warts A-249, 250

3. d Somewhat oblong to egg shape, an eighth of an inch in length, with a little point at the broad end; the surface is nearly smooth or with inconspicuous longitudinal angles or ridges, and by their generally light gray to cream color. A-250

4. c More or less oblong and nearly straight shape, an eighth of an inch in length slightly narrowed at one end, dull brown in color, except for the collar at the top which tends to be yellowish A-25

5. a Nearly smooth reddish-brown color, one eighth inch in length, somewhat football shaped and slightly flattened with a furrow running down each of the sides to the narrow end. A-249

Listing

1. Nebraska State Seed Laboratory A-242
Department of Agriculture
State Capitol Building
Lincoln, Nebraska

2. a. Use official mailing envelopes, or cloth bags, tin boxes, or heavy seed packets for packing.
   b. Each sample envelope should bear the sender's name and the sample lot number. Seed parcels may be sent by parcel post.
   c. A first-class letter should be attached to the parcel with the information enclosed concerning the type of service desired.
   d. Checks or money should not be enclosed in the seed containers. A-24

3. $$\frac{\text{Expected quality} \times \text{Recommended seeding rate}}{\text{Purity} \times \text{Germination}} = \text{Adjusted seeding rate}$$
A-246

4.

Alfalfa	.83	Lespedeza	.78	Small grains	.83
Red clover	.83	Bromegrass	.68	Soybeans	.78

A-247

5. $$\frac{.83 \times 10}{.95 \times .80} = \frac{8.3}{.76} =$$ 11 pounds per acre A-247

6. a. The seeds are less than an eighth inch in length in diameter and varies in shape.
   b. Seeds are spheriod or ellipsoid but are often irregularly "lumpy" with some of the sides flattened.
   c. Well developed and viable seeds are generally bright tan to brownish, sometimes with a tinge of green. Diseased or immature dark brown or ashy gray seeds are frequently found mixed with the good ones. A-256

7. a. Kill diseases, organisms inside and outside the seed.
   b. Protect the seed against root rotting fungi in the soil. A-258

8. a. Mixing chamber, in which the seed is covered with the liquid.
   b. Mist-type treater, where the disinfectant is sprayed as a mist directly on the seed. A-258

9. a. Avoid inhaling dusts or fumes when treating. The fumes are either poisonous or irritating.
   b. Treat in a well-ventilated place or outdoors. An exhaust system is highly desirable.
   c. Follow the manufacturer's directions. A-258

10. (7.7 percent ethyl mercury p. toluene sulfonanilide)
A dust or slurry treatment.
An orange, wettable powder, poisonous to man and animals.
Avoid contact or inhalation.
Used to control smuts, bacterial blights, seed rots, etc., on oats wheat, barley, flax, sorghum, sugar beets, and tomato. A-258

11. (2.2% methylmercury dicyandiamide)
A poisonous red liquid volatile mercury compound widely used in treating oats, wheat, barley, flax, and rye to control smuts, seed rot, seedling blights, scab, etc.
It is applied directly to the seed using liquid treaters or diluted for use in slurry treaters. A-258

12. (75% tetramethyl thiuram disulfide)
A pink, non-wettable organic sulfur powder with good sticking properties.
Kills seed borne organisms. Protects corn, sorghum, vegetables, flowers, small seeded legumes, soybean, and grass seed against seed r
Toxic to certain persons, so avoid contact or inhalation. A-259

13. (75% N-(triachloromethylthio)-tetrahydrophthalimide)
A pale yellowish wettable organic chlorine and sulphur compound proving very useful on many crops, especially corn, small-seeded legumes, vegetables, grasses, flowers, cereals, soybeans, and other seed to kill seed borne organisms and protect against seed rot and damping-off. Very low toxicity. May be used as a dust or slurry treatment. A-260

14. a. Alfalfa group: alfalfa, sweetclover (yellow, white Hubom).
   b. Clover group: red, white ladino, alsika, crimson, and mammoth.
   c. Pea group: Peas (field, garden, Austrian winter), vetch (common hoary, purple).
   d. Cowpea, lespedeza group: Cowpea, lespedeza (Korean and common), kudzu, peanuts, lima beans, Crotalavis.
   e. Bean group: Garden, kidney, navy, Great Northern.
   f. Lotus group: Birdsfoot trefoil.
   g. Soybean group: Soybeans, all varieties.
   h. Lupine group: lupine (blue, yellow, white). A-170

15. a. The seed must have come from foundation or certified seed stocks.
   b. The crop is field inspected by a representative of the certifying agency just prior to harvest.
   c. The field must have been in some other crop the previous year, except in the case of perennial grasses.
   d. The field must not contain noxious weeds, excessive variety mixture, or mixtures of other crops.
   e. After harvest a sample of the seed must meet rigid requirements as to purity and varietal mixtures.
   f. Small grains and soybeans must germinate at least 85%, and bromegrass 80%. A-175

16. a. Cool season--oats, winter rye, and mape.
   b. Warm season--sudangrass, soybeans, millet, and sorghum.

17. Refer to Reference B--(c.c. 178).

UNIVERSITY
OF
NEBRASKA

ED035773

AGRICULTURAL SUPPLY, SALES, AND SERVICE OCCUPATIONS

Crop, Lawn and Garden Seeds Sales and Service Occupations

Part IV

James T. Horner

C. Edward Henderson

James J. Albracht

Publication No. 8

VT010341

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

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Adapted for Student Use from

CROP, LAWN, AND GARDEN SEEDS
SALES AND SERVICE

One of Twelve Modules in the Course Preparing for Entry in

AGRICULTURAL SUPPLY - SALES AND SERVICE OCCUPATIONS

Module No. 8

The Center for Research and Leadership Development
in Vocational and Technical Education

The Ohio State University
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Columbus, Ohio, 43212

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from the
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CROP, LAWN AND GARDEN SEEDS, PLANTS, AND SUPPLIES--SALES AND SERVICE

Major Learning Objective

To develop the understandings and abilities needed to enter and advance in employment in the retail outlets for farm and garden seeds, plants, supplies, and related materials.

Introduction

Until recently, most farm crop seeds were sold directly by producers to the farmer. Small quantities of garden and lawn seeds were handled by hardware, grocery, or feed supply stores. In some areas, local elevators purchased seeds from growers and resold them to farmers. As improved crop seed and plant materials have become available, the distribution of these items has changed. Companies which previously dealt only in seed and plant materials have taken over the production and distribution of many of these items. These companies and other businesses handling crop, lawn and garden seeds, plants and supplies are employing increasingly large numbers of sales personnel. These developments and the growing need for trained salesmen provide the background for the material presented in this unit.

An employee in agricultural supply--sales and service occupations will usually have to handle more than one area or product. While he may specialize in one or more lines and may team with another worker to provide service to customers, he will be expected to have a broad working knowledge of both sales and service. Although initially an employee may do largely the work of unpacking and arranging stock, or even sweeping and dusting, there is no reason why advancement up the merchandising ladder of sales and service should not take place. The usual progression is from clerk to product salesman, to head salesman, or servicemen to positions on the managerial level.

Revised editions of the Dictionary of Occupational Titles or similar works such as the Handbook of Agricultural Occupations[1] clarifies the job description of the workers in agricultural supply--sales and service occupations at the retail level. It is suggested that teachers use any or all of those appearing in the current edition of the Handbook of Agricultural Occupations as applicable, including the following:

	Page
County Store Clerk	118
Farm Hardware and Equipment Store Employee	120

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[1] Hoover, Norman K. Handbook of Agricultural Occupations (Danville, Illinois: The Interstate Publishers and Printers, 1963).

	Page
Feed Mill Employee	121
Farm Cooperative Service Store Employee	123
Farm Equipment and Supply Salesman	126
Grain elevator (Feed Mill) Employee	127
(Truck Driver- Salesman)	127
Garden Center Employee	198
Landscape Gardener	206
Golf Course and Lawn Worker	199

In many respects, the job description for a garden center employee most nearly describes the employee to which this unit applies. However, there is no mention of sales which is a major feature of this unit. By adding and emphasizing the sales responsibility to the garden center employee's job description or by adding this to other job descriptions needing sales competencies, the student can become better informed and trained for the jobs becoming available.

Using these listings, develop a list of business establishments offering complete or partial coverage on items of local needs for seeds and related plant materials. Develop an understanding of the functions usually performed by a business establishment in serving its clientele for seeds, plants and service. Such a list might include:

1. Sells both crop and garden seeds
2. Sells either field or garden seeds but not both
3. Sells lawn seeds as speciality as well as crop and garden seeds
4. Sells seasonal garden plants as well as seeds
5. Sells ornamental plants as well as garden plants and seeds
6. Sells trees (orchard, ornamental, forest) as well as seeds and plants
7. Sells fertilizers (organic, inorganic, combination) as well as seeds and plants
8. Sells mulching materials (plastic, peat, corn cobs, straw, as well as seeds, plants, and fertilizers)

9. Sells garden tools and equipment, sprayers, dusters, pruning tools, in addition to seeds and plants

10. Sells pesticides including rodenticides, as well as seeds and plants

11. Provides planning for application service* in addition to sales

12. Provides consultation service at store

13. Provides consultation services including detailed planning* at prospective purchasers home

14. Provides complete sales and service* for all aspects of the agricultural supply business

Consider the type of agricultural business in which you would like to be employed. The competencies which will be required for job entry and success should also be considered.

Students should work on the basis of their abilities and interests. This work should encourage individual students to appraise themselves. A form such as the one illustrated here could be used for self-appraisal.

Competency Required	For Entry	For Success	Possesses at Present	Needs to be Developed	What Can This Course Do to Develop

The order in which the competencies are achieved may be varied. However, several factors were considered in developing the order in which they are listed. Primary importance is given to starting with the simplest competency and progressing to the more complex. Crop and garden seeds are listed as assignments Number 1 and 2 in order to give the student a basic background in these areas before going to the other assignments. This order also reflects the probable job sequence that the new employee would follow in on-the-job training. The adaptability and flexibility of this outline for student use was also considered in developing the sequence. The needs of students should be the basis on which the use of this unit is studied.

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*Indicates the service for which a charge is made, if not included in the cost of the material purchased.

No attempt is made in this unit to teach such basics as (1) the nature and properties of soils, (2) principles of plant growth, (3) the chemistry of fertilizers and pesticides. Much of this material is ordinarily covered in the early years of a conventional vocational agricultural course. It is presumed that most students in an Agricultural Supply--Sales and Service course will have already completed basic work in these areas.

A seed store or garden center exists to make a profit for the owner or owners. The primary purpose of the employee is to insure this by increasing the volume of business. Regardless of whether the retail sales or service man is working for a fixed wage or is on a commission, or a combination of both, there is a direct relationship between his volume of work and what the employer can pay him. While many may enter this occupational field, those who cannot produce on a long time basis will be eliminated, while others will advance in earnings and positions of responsibility.

It is important that students develop the abilities they need to become the type of employee who will help increase the profit of the agricultural supply business.

ANALYSIS OF CROP, LAWN, AND, GARDEN SEEDS, PLANTS, AND SUPPLIES

ABILITIES: To develop the ability to	Assign. No.	UNDERSTANDINGS: To develop the understanding of
	Crop Seeds	
1. Judge the quality of the seeds	1	1. Methods of taking seed samples and procedure for mailing seed samples
2. Select cereal, grass, and legume varieties	1	2. Evaluative criteria used for seed testing and criteria used for certifying seed
3. Treat cereals, legumes, and grasses	1	3. Recommended cereal, grass, and legume varieties
4. Innoculate legumes	1	4. Methods of treating seed and the treating materials used
5. Determine pure live seed	1	5. Groups of legume families and types of innoculants
6. Plant cereal, grasses, and legumes	1	6. Procedure for determining pure live seed
7. Identify weed seeds	1	7. Rates, dates, and depths of planting cereals, grasses, and legumes
	1	8. Characteristics of weed seeds
	Garden Seeds	
8. Prepare garden seedbed	2	9. Principles and methods of seedbed preparation
9. Fertilize garden	2	10. Principles and methods of fertilizing gardens
10. Select garden seed	2	11. Types and kinds of garden seeds
11. Plant garden seeds	2	12. Rates, depths, and dates of planting
12. Control garden diseases	2	13. Types of garden diseases and their methods of control
13. Control garden insects	2	14. Types of garden insects and their methods of control

ABILITIES To develop the ability to	Assign. No.	UNDERSTANDINGS To develop the understanding of
Products Offered for Sale and Usage of These Products		
14. Identify and group products offered for sale	2	15. Why items are grouped in various categories
15. Recommend a specific product to meet customers needs	2	16. Customer needs, and the types that will be best suited for individual situations
16. Know what products are available	2	17. Methods used in grouping various products
	2	18. The strengths and limitations of each particular product
Types and Usage of Various Plant Materials and Factors in Plant Material Production that Benefit Customers		
17. Recommend usage of various plant materials	3	19. The types of plant materials
18. Interpret state registration and certification standards	3	20. The factors involved in plant material production
19. Evaluate seed production processes	3	21. The factors involved in producing certified seed
Interpreting Information on Tags or Labels on Containers		
20. Interpret information on seed tags	4	22. The laws and regulations that contain information on tags or labels
21. Interpret information contained on labels of various containers	4	23. The purposes of various seed laws
22. Recommend correct varieties for specific customer needs	4	24. Variety information
Services offered Which Require the Use of Special Equipment and a Comparison of the Quality of Products Offered		
23. Advise customers on culture practices	6	25. Why special services are necessary

Assignment
No. 3

PRODUCTS OFFERED FOR SALE AND USAGE OF THESE PRODUCTS

A seed store or garden center exists to make a profit for the owner or owners. The primary purpose of the employee is to insure this by increasing the volume of business. The employee must have a complete knowledge of the products offered and what these can do for the customer. He must know the function of his products and be able to recommend to the customer the specific type of product to use under each existing circumstance.

An individual will have difficulty in knowing everything about each item offered for sale in agricultural supply businesses prior to starting work, and possibly even after several months or years. For this reason, it is necessary that he acquaint himself with as much of the products as soon as he can and always continue learning more about the supplies available.

The following assignment is designed to acquaint you with some of the basic products and their use.

Assignment:

1. Read the references listed below.
2. Answer the questions concerning this assignment in the Question Manual and turn in the assignment when completed. (Suggested time allotment for this assignment: 2 to 3 hours.)

References:

X. Crop, Lawn and Garden Seeds. Sales and Service Module No. 8 Agricultural Supply - Sales and Service Occupations. The Center for Research and Leadership Development in Vocational and Technical Education, Columbus, Ohio. (Material following)

To know what products are offered for sale and usage which can be made of these products by the purchaser

While not all seed or garden stores may offer all of the following items, it may be helpful to group them somewhat as follows:

Field or crop seeds
Garden seeds
Green plants
Shrubs or bushes
Trees
Bulbs and tubers
Miscellaneous plants
Mushrooms
Lawn seed
Lawn sprigs or plants
Fertilizer materials
Herbicides
Insecticides
Rodenticides
Inoculants
Seed treatments
Mulching materials

DESCRIPTION	CUSTOMER USE
Field or Crop Seeds	
Dry materials, relatively nonperishable, usually sold in bulk or large quantities. Used for the production of feed for livestock or commercial quantities of food for man.	-Cereal grains; for feed and food. Forages; for hay, silage, soilage, and soil improvements. Oil seeds for oil and animal feed. -Cotton; for fiber and oil seed. -Tobacco; to plant in beds for transplanting. Specialty crops.
Garden Seeds	
Generally divided into flowers for ornamental purposes and garden crops for food production. Usually sold in packages although commercial producers may buy in quantity lots.	-Flowers for home beautification or commercial resale. Garden crops for consumption or sale in the green or perishable state, mature fruits, or seeds.
Green Plants or Sets	
For ornamentals or food. Produced from seed and sold to the customer to shorten the growing season or maturity time. Usually sold in "flats" or "pots," but may be taken directly from hotbed or coldframe.	-Flower plants may be for outside or inside use. Garden plants may be in small lots for home gardens or bulk quantities for market gardening and machine setting in field production.
Shrubs or Bushes	
Usually perennial with woody growth. May be in dormant or growing stages depending on the time of year and type of plant. Shrubs are usually for home beautification or landscaping with the term "bushes" usually denoting food production.	-For home planting either for beautification or food, or commercial planting for resale.
Trees	
Usually dormant or "balled," or dug on customers' order for immediate replanting. May be for fruit, seed, nuts, or ornamental. Usually several different heights, and possibly several different years of previous growth.	-Variety of uses; for shade, beauty, food, forest or windbreak purposes.

DESCRIPTION	CUSTOMER USE
Bulbs, Tubers, Corms	
Underground plant parts used for the production of new plants either ornamental or for food.	-Bulbs and corms usually for flowers. -Tubers for flowers and shrubs, or food.
Miscellaneous Plants (Grape Vines)	
Hardwood cuttings which have been rooted and possibly grafted	-Fresh fruit, juice, and wine production
Mushrooms	
Bricks of spawn used to start fruiting when spread upon compost material under proper conditions for growing	-For limited home use or commercial production
Lawn Seed	
Individual varieties or combinations to meet varying conditions: shade, rapid growth, to stand usage, color, texture, home lawns, or golf courses	-Kentucky blue, best all round -Fescue, rapid establishment -Bermuda, stands hard treatment -Merion blue, expensive -Orchard groves, shade -Ryegrass, fall seeding, turf establishment
Lawn sprigs or plants	
Creeping bent grasses or Bermudagrass	-Provides cushiony turf when established
Fertilizer Materials	
For starting plants, liquid or dry	-Small packages for making starter solutions for transplants
For home garden, organic, inorganic	-Packages and smaller sacks for house plants and gardens
For commercial gardens and greenhouses	-High analysis, heavy in nitrogen 50-80 lb. bags
For lawns and golf courses	-Specialized analysis and formula for specific situations
In combination with herbicides	-Turf building

These miscellaneous supplies are covered in detail in another module of this series. The wide diversity of materials handled in various areas and by different stores makes it difficult to identify all of these items. The teacher should determine what should be included in those modules based upon local use and availability.

Suggested Learning Activities

An individual will have difficulty in knowing everything about each item offered for sale in agricultural supply businesses prior to starting work, and possibly even after several months or years. For this reason, outlets with more than one clerk usually develop some departmentalization with one person concentrating on certain groups of products. However, there must always be coverage over noon hours, evening hours, or vacation periods. Therefore, each clerk should have a working knowledge of all items and products, even though he specialized in just a few.

Initially, the goal should be to develop overall competency with specialization developing at a later date according to interest aptitude. While a group visit to a representative farm supply store when beginning this unit may be introductory and interest arousing, many of the learning activities of this competency can be carried out by students using their own time as individuals to develop their knowledge by observation and discreet questioning in various retail outlets for farm supplies.

The learning situation might be developed about as follows:

1. Develop your knowledge by visits to retail outlets. This will help broaden your previous knowledge by checking on specific matters and items with which you are not familiar.

2. Read current and past issues of farm and garden catalogs, magazines, special columns in daily or weekly papers, listen to farm programs over the radio, or watch television farm programs to further increase your product knowledge.

Suggested Instructional Materials and References

1. Seed and farm supply catalogs

2. Farm and garden magazines

Suggested Occupational Experiences

1. Work in a retail outlet is the best way to develop this competency. This may be part time or full time, during the school year or summer vacation, and in either sales or service capacities.

2. Work in the merchandising of products of the school farm, greenhouse or individual home projects is also satisfactory to provide the same work experience for this competency.

3. Work in production or marketing phases of farming or commercial gardening will be helpful in developing certain aspects of this competency.

4. When actual experience is not possible, observation and class reports may be substituted to help develop this competency.

ED035773

STUDENT WORKSHEETS

Agricultural Supply, Sales, and Service Occupations
Crop, Lawn, and Garden Seed Sales and Service Occupations
Part IV

(Supplement to Publication No. 8)

VT010341

Assignment
Worksheet No. 2

GARDEN SEEDS

True - False

Directions: The following statements are either true or false. If the statement is true, draw a circle around the letter "T". If it is false, draw a circle around the letter "F".

T F 1. The garden should be plowed early in the spring under normal conditions.

T F 2. A low state of fertility results in slow growth and stunted plants.

T F 3. Unlimited amounts of manure should be added to the garden soil.

T F 4. Lime should be added to all garden soils in Nebraska.

T F 5. Chlorosis is especially evident in tomatoes and corn.

T F 6. The chemical treatment of vegetable seeds materially assists in giving a better stand and more vigorous seedlings.

T F 7. Dusting is superior to spraying for the control of plant diseases.

T F 8. Chemicals used for disease control are protective agents and are not curative.

T F 9. Incomplete coating with fungicides enable disease organisms to produce infections in the unprotected areas.

T F 10. Insect control should be considered separately from the general disease control program of the garden.

T F 11. The most efficient insect dusters are the shaker-top cans.

T F 12. In spraying to control garden insects the spray nozzle should be directed upward to cover the bottom side of the plant leaves.

Completion

Directions: Fill in the blank(s) in each statement with the word(s) required to complete the sentence correctly.

1. The garden should be plowed __________ inches deep if the soil is heavy and at a depth of __________ inches if the soil is sandy.

2. When the garden soil is sandy and likely to blow, the plowing should be done in the __________.

3. Barnyard manure should be added to garden soil at the rate of __________ pounds of well-rotted manure per square rod per year; or about __________ this amount in the case of chicken or sheep manure.

4. __________________ can be used in the place of barnyard manure.

5. If manure is used, commerical nitrogen on tomatoes, cabbage, and sweet corn may be applied as a __________ __________.

6. The commercial nitrogen should be applied in a band __________ inches away from the plants and __________ inches deep.

7. Too much nitrogen at planting may result in excessive __________ of potatoes and tomatoes.

8. It is often desirable to __________ the application of commerical nitrogen between pre-plant and dise-dress applications.

9. The acidity of your soil may be determined by having a soil sample tested by the Soil Testing Service at the __________ __________

10. Alkaline or limey soils are usually deficient in __________ __________.

11. Yellow chlorotic plants are usually caused by an __________ __________.

12. A wetting agent such as a __________________ should be added to the spray solution to obtain better surface coverage of the garden plants.

13. Good garden fungicides are __________, __________, __________, and __________ containing materials.

14. Most plant virus diseases are spread by various __________, __________, and __________.

15. It is necessary to __________________ the garden soils in order to control the parasitic nematodes.

16. Fumigating the soil with a nematicide such as __________, __________, or __________ will restore the soil for immediate general garden use.

17. Insects and mites live and feed mainly on the __________ of leaves.

Multiple Choice

Directions: In the space at the left of each statement, write the letter of the item which will provide the correct answer to complete the statement.

_____ 1. The best type of duster for controlling garden insects is the:
- a. Shaker-top can
- b. All metal, plunger type hand duster
- c. Bag duster
- d. Open can with the top covered by cheese cloth

_____ 2. The best type of sprayer for the average-sized garden is a:
- a. Hand sprayer that gives a continuous spray and that has a two-way nozzle to direct the spray upward.
- b. Small, single-action atomizer type of hand sprayer.
- c. Compressed air sprayer equipped with an extension rod and angle nozzle to direct the spray upward.
- d. Hand sprinkler can.

Listing

Directions: List the items called for in each of the following. Select your answers carefully.

1. If the garden must be very limited in size, important considerations are as follows:

   a.

   b.

   c.

   d.

   e.

2. The following vegetables produce the greatest nutritional value for the space used. (13)

   ______________________ ______________________

   ______________________ ______________________

   ______________________ ______________________

   ______________________ ______________________

________________________ ________________________

________________________ ________________________

____

3. The fall plowing of the garden just before hard freezes has the following advantages:

   a.

   b.

4. The application of barnyard manure to the garden soil has the following advantages:

   a.

   b.

   c.

5. If barnyard manure has not been used regularly, and the soils are low in phosphate, commerical phospate fertilizer should be added as follows:

Phosphate fertilizer	Per cent of available phosphate	Lbs. per sq. rod
________________________	_______	________
________________________		
________________________	_______	________

6. Nitrogen fertilizers should be applied each year on gardens when little or no manure has been used, and in addition to manure on tomatoes, cabbage, onions, sweet corn, and lettuce.

	Pounds recommended per square rod	
Nitrogen fertilizer	In addition to the manure	Where no manure has been applied
30% to 40% nitrogen		
______________		
______________	____________	____________

20% to 30% nitrogen

____

____________________ ______________ ________________

10% to 20% nitrogen

____________________ ______________ ________________

7. Mixed fertilizers are usually applied to the garden at the following rates:

Mixed fertilizer formula	Lbs. per square rod
__________________________	__________
__________________________	__________
__________________________	__________
__________________________	__________
__________________________	__________

8. The best method of combating garden diseases is through good cultural practices as follows:

a.

b.

c.

d.

e.

f.

g.

9. Give the insecticide and formulation, amount of insecticide per 1 gallon of water, and special directions and precautions in using the insecticides for controlling the following vegetable insects.

Insect	Insecticides and Formulation	Amount per 1 gal. of water	Directions and Precautions
Aphids (tomatoes)	______	______	______
	______	______	______
	______	______	______
	______	______	______
Cucumber beetles	______	______	______
	______	______	______
	______	______	______
Colorado potato bettle	______	______	
	______	______	
	______	______	
	______	______	
Wireworms, cutworms	______	______	______
Leafhoppers	______	______	______
	______	______	______
Red spider mites	______	______	______
	______	______	______
Flea beetles	______	______	______
	______	______	______

10. List the approximate planting dates for each of the following vegetables:

Vegetable	Planting date	Vegetable	Planting date
Lettuce	____________	Beans	____________
Cabbage	____________	Tomatoes (transplant)	____________
Beets	____________	Egg plant (transplant)	____________
Peas	____________	Watermelon	____________
Sweet corn	____________	Muskmelon	____________

TEACHERS KEY

ED035773

Agricultural Supply, Sales, and Service Occupations
Crop, Lawn, and Garden Seeds Sales and Service Occupations
Part IV

(Supplement to Publication No. 8)

VT010311

Teachers Key
Assignment Worksheet
No. 2

GARDEN SEEDS

1.	False	A-3
2.	True	A-3
3.	False	A-4
4.	False	A-5
5.	False	A-5
6.	True	A-8
7.	False	A-8
8.	True	A-8
9.	True	A-8
10.	False	A-9
11.	False	A-9
12.	True	A-9

Completion

1.	6 to 8, 5 to 6	A-3
2.	early spring	A-3
3.	100 to 200, one-half	A-4
4.	Commercial fertilizers	A-4
5.	side dressing	A-5
6.	4 to 8, 2	A-5
7.	top-growth	A-5
8.	divide	A-5
9.	College of Agriculture	A-5
10.	available phosphate	A-5
11.	iron deficiency	A-5
12.	household detergent	A-8
13.	Captan, Zinib, Maneb, Copper	A-9
14.	aphids, leafhoppers, thrips	A-9
15.	fumigate	A-9
16.	methyl bromide, D-D, nemagon	A-9
17.	underside	A-9

Multiple Choice

1. b. All metal, plunger type, hand duster A-9

2. c. Compressed air sprayer equipped with an extension rod and angle nozzle to direct the spray upward A-9

Listing

1. a. Plant only those vegetables the family will use, and plant only enough of a given kind to satisfy the family needs.
   b. Grow those vegetables that produce the greatest nutritional value for the space used.

c. Grow those vegetables that are usually more expensive in the local market.
d. Plant rows closer together where additional water and fertilizer can be applied.
e. Trellis vine crops, by pruning and staking tomatoes. A-3

2. Carrots
Potatoes
Onions
Beets
Lettuce
Broccoli
Cabbage
Winter squash
Turnips
Spinach
Snapbeans
Tomatoes
Radishes A-3

3. a. Cutworms and insects are brought to the surface and exposed to their natural enemies and cold weather.
b. The soil surface is left rough enough to catch snow, and to increase the mellowing effect of freezing and thawing. A-3

4. a. Increases the supply of nitrogen, phosphorus, and other necessary elements of the soil.
b. Adds to the water holding capacity of the soil.
c. Improves the physical condition of the soil. A-4

5.

Superphosphate	20	4-6	
Double or treble Superphosphate	45	2-3	A-4

6.

30% to 40% nitrogen			
Urea (Uramon, Nugreen)			
Ammonium nitrate	1	1-2	
20% to 30% nitrogen			
Ammonium sulfate			
Calnitro, Ammonium sulfate nitrate	1-2	2-3	
10% to 20% nitrogen			
Sodium nitrate	2-3	3-4	A-4

7.

16-20-0			2-3	
10-20-0	10-10-5	9-7-4	4-6	
6-2-0	6-10-0	6-9-7	6-8	
4-16-0	5-10-5		8-10	
4-4-4			10-12	A-5

8. a. Plant disease-free seed. Obtain the seed from reliable seed concerns.
b. Plant those varieties known to be resistant to some of the common diseases, as for example, wilt-resistant tomatoes and watermelons and mosiac-resistant beans.
c. Rotate the different vegetables by groups within the garden area. If possible, rotate the garden area itself, to prevent diseases carried over winter in the decaying plant parts.
d. A well-drained garden will help control root rot diseases.

e. Thin seedlings to proper spacing when they are small, to allow proper airing which will help reduce leaf-spot diseases.
f. Destroy weeds as they are overwintering hosts of common garden diseases.
g. Keep the plant well watered and fertilized; the healthy plant is more resistant to disease.

A-8

9.	Malathion, 50% E C	2 teaspoons	Apply to undersides of leav
	Malathion, 4% dust	Apply as dust	Do not apply malathion dust when vines are wet
	Potenine, 0.75% dust	Apply as dust	
	Nicotine, 40%	2 teaspoons	Add soap powder to nicotine sulfate
	Methoxychlor, 5% dust	Apply as dust	Begin treatment when plants first come through the soil; repeat every week
	Methoxychlor, 50% WP	2 tablespoons	
	Rotenone, 0.75% dust	Apply as dust	
	DDT, 5% dust	Apply as dust	
	DDT, 50% WP	3 tablespoons	
	Methoxychlor, 5% dust	Apply as dust	
	Methoxychlor, 50% WP	3 tablespoons	
	Chlordone, 5% dust	5-10 lbs. per 1000 sq ft of garden area	Apply before planting and rake or spade into soil
	DDT, 10% dust	Apply as dust	Do not use DDT after pods form
	Rotenone, 0.75% dust	Apply as dust	Use rotenone after pods form
	Malathion, 50% E C	3 teaspoons	Spray underside of leaves
	Armote, Dimite, & Ovatron	Follow package directions	Spray underside of leaves
	Methoxychlor, 5% dust	Apply as dust	Use rotenone as heads form
	Rotenone, 0.75% dust	Apply as dust	

A-12

10.	Lettuce	April 1-15
	Cabbage	April 1-15
	Beets	April 1-15
	Peas	May 1-15
	Sweet corn	May 1-15
	Beans	May 1-15
	Tomatoes--transplant	May 15-31
	Eggplant--transplant	May 15-31
	Watermelon	June 15
	Muskmelon	June 15

A-14

UNIVERSITY
OF
NEBRASKA

ED035773

AGRICULTURAL SUPPLY, SALES, AND SERVICE OCCUPATIONS

Petroleum and Petroleum Products Sales and Service Occupations

Part V

James T. Horner

C. Edward Henderson

Publication No. 9

THE NEBRASKA AGRICULTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

VT010311

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Adapted for Student Use from

PETROLEUM AND PETROLEUM PRODUCTS
SALES AND SERVICE

AGRICULTURAL SUPPLY - SALES AND SERVICE OCCUPATIONS

The Center for Research and Leadership Development
in Vocational and Technical Education

The Ohio State University
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PETROLEUM AND PETROLEUM PRODUCTS

Introduction

The petroleum industry is very important to agriculture and agriculture production today. Petroleum and its products are handled by many agricultural supply businesses and its distribution to farmers performs a much needed service. There lies a need for persons in the sales, supply and service of petroleum and petroleum products. Unless the operation is unusually large, retail sales and deliveries are usually handled as a part of the general work.

The opportunities for students to gain occupational experience while in high school are decidedly limited and are usually only as filling station employees. Very few agricultural supply businesses, except in some mid-western states, operate service stations comparable with those of the major oil companies. Young men must be at least 18 years of age before they can secure a license to operate a tank truck, there is practically no need for a "helper," and company policy may preclude riding as an observer in a non-paying status. However, the known willingness of rural youth to work hard, their reputation for reliability growing out of their experience in agriculture, and their ability to "speak the same language" when talking with farmers, gives them an advantage when being considered at the proper age for employment as driver-salesmen.

The major portion of the petroleum business in a farm supply center is in products delivered to the farm, i.e., gasoline, diesel fuel, LP Gas, heating oil, and lubricants with store sales confined largely to kerosene, oils, lubricating greases and accessories. While the ability to drive a tank truck properly is a major consideration for employment, the eventual value to the company and the amount of individual earnings will depend upon the individual's sales ability and the rapport he establishes with his customers during normal service operations. This unit emphasizes the sales and service aspects of the delivery of petroleum products to the farmer, and the retail sales work of the appropriate products in the farm supply store by non-specialized salespersons.

The opportunities for employment in this field may be limited on the local level to entry level occupations such as the filling station employee; however, an informal survey by the student will be a good way to secure further information on the occupation. This may be done concurrently with a presentation of the points brought out above or following their discussion. The students will immediately become aware that they cannot hope to become delivery men servicing farmers until they are mature enough to assume the responsibility for driving a large truck loaded with potentially explosive products, and of making recommendations in the course of developing their clientele as a business man, rather than as a delivery man.

Practically all petroleum employees operate under some kind of an incentive plan which rewards the individual who have initiative, ability to learn, and ability to sell his services as well as his product. The petroleum driver-salesman who is content to remain a truck driver or product delivery man will make a satisfactory living, but for the individual who is willing to develop his sales technique to the place where his volume increases, the number of stops decrease, and the length of the route shortens (or he services more customers by working longer hours), it is possible for him to make enough money ($500.00 or more a month) for it to be a lifetime career.

Advancement may be from a driver-salesman to a full-time outside salesman or directly to the petroleum manager for a farm supply center or petroleum distributor. Some individuals may have the ability and capacity to progress in management, to become an assistant, and possibly a general manager of an agricultural supply business. A few may care to establish their own business, buying wholesale and delivering to retail customers on the farm or in rural communities. However, this involves a tremendous investment in storage facilities and trucks, so that although financing can be obtained in many instances from major producers, one is probably better off (at least for a number of years) working for a company rather than attempting an individual business which is under-capitalized.

The farmer relies on others who are specialists in the petroleum industry to keep him informed on current problems and developments. He looks for assistance in planning and supplying needed petroleum products that best fit his individual needs. As a worker in any phase of the petroleum industry, you are a valuable member of the team in supplying your customers and prospective customers with products and information. A thorough knowledge of your product is essential to your success.

The following nine assignments have been developed to better equip you with the knowledge and skills necessary to be a success in any occupation pertaining to the supply, service, sales, and distribution of petroleum or petroleum products. This information or parts of this information may be covered in the regular vocational agriculture program.

The technical information and information sheets contained in this unit are taken directly from material prepared at the Center for Research and Leadership Development in Vocational and Technical Education, The Ohio State University, 980 Kinnear Road, Columbus, Ohio 43212, under Module No. 11 (Petroleum and Petroleum Products Sales and Services) of Agricultural Supply-Sales and Service Occupations.

When you are working out each assignment you should first read the material assigned carefully, then answer the questions in the student study question manual. Once you have completed the questions, have them checked by your teacher coordinator and go back and rework any that you missed. When there are activities listed these should be carried out to the best of your ability. All the references, including visual and audio-visual aids, should be studied with the utmost of care.

PETROLEUM AND PETROLEUM PRODUCTS
SALES AND SERVICE OCCUPATIONS

Competencies to be Developed

ABILITIES To develop the ability to:	Assign. No.	UNDERSTANDINGS: To develop the understanding of
Selecting Tractor and Power-Equipment Fuels		
1. Recommend proper tractor and power equipment fuels to customers	1	1. Proper octane rating
2. Quote prices of various fuels to customers	1	2. Fuels for two-fuel, diesel, LP gas and gas tractors
3. Advise customers on use of fuel activities	1	3. The costs of the various types of tractor and power fuels
	1	4. The uses of various fuel additives
Storage Facilities for Tractor Fuels on the Farm		
4. Recommend proper petroleum storage systems	2	5. Underground and above ground storage systems
5. Advise customers on safety precautions in storing tractor fuels	2	6. Safety precautions necessary in storing tractor fuels
Selection of Motor and Lubrication Oils		
6. Know the grades of oils that should be used in various farm tractors	3	7. SAE number of oils and lubricants
7. Advise customers on which types of oil would best fit their needs	3	8. The use of API service classifications
	3	9. The use of additives in oils

ABILITIES To develop the ability to:	Assign. No.	UNDERSTANDINGS To develop the understanding of:
Selection of Gear Oils, Lubricating Greases and Hydraulic Oils		
8. Select proper gear oils and lubrication greases	4	10. The proper uses of gear oils and lubrication greases
9. Advise on proper usage of hydraulic oils	4	11. Additives in gear oils and lubricating greases
	4	12. The usage of hydraulic oils
Selection, Delivery and Storage of Heating Oils		
10. Recommend proper types and storage of heating oils to be used	5	13. Proper selection and storage of heating oils
11. Recommend safety precautions which should be followed in handling heating oils	5	14. Flash point rating of fuel oils
	5	15. Safety precautions in handling heating oils
Products Other Than Petroleum Available to Farmers Through Tank-Drain Salesmen		
12. Recommend kinds and types of antifreeze to use	6	16. Various types of antifreeze
13. Advise on purchase of tractor tires	6	17. Proper tractor tire usage
14. Advise on purchase of oil filters	6	18. Types of oil filters
Contractual Relationship of Company to the Petroleum Employee and Employees to the Customer		
15. Fill out customer order and purchase forms	7	19. Customer purchase forms
16. Properly grease check and maintain tank-truck	7	20. Company policy concerning credit and discounts
	7	21. Proper care and maintainance of tank-wagon

ABILITIES To develop the ability to:	Assign. No.	UNDERSTANDINGS To develop the understanding of:
Safety Laws and Regulations Pertaining to the Delivery and Storage of Liquid Petroleum		
17. Clean and check fuel storage tanks	8	22. Safety laws pertaining to fuel
18. Repair fuel storage tanks	8	23. Proper use and storage of fire extinguishers
	8	24. Safety procedures in cleaning a storage tank
	8	25. Safety precautions in repairing a storage tank
Safe Tank-Truck Operation and Requirements for a Chauffeur's License		
19. Pass tests necessary for receiving a chauffeur's license	9	26. Requirements for a chauffeur's license
20. Meet customers in friendly manner and use correct procedures when delivering fuel and products to customers	9	27. Federal regulations pertaining to truck operations
	9	28. Delivery procedures
	9	29. Safety in handling a tank-truck

Assignment
No. 1

SELECTING TRACTOR AND POWER-EQUIPMENT FUELS

The major source of income to the tank truck driver salesman is from delivering tractor fuels to farmers. He has just as great a stake as the farmer in being sure that the proper fuel is used for a given tractor. He must make sure that his recommendations are based on sound facts and in line with recommendations in the operator's manual, or the delivery of the improper fuel may well cost him a customer and decrease his income if he is on a commission.

The tank truck driver or filling station employee should know and understand the various types of fuels that are available and the type of fuel that is recommended for each type and make of tractor. The operator's manual recommends the correct fuel for each individual engine the farmer has on his place; however, he often relies on the tank truck operator or petroleum station to supply him with the proper fuel and information on various fuels.

The assignment below will give you an opportunity to better understand the types and kinds of fuels and to be able to select the proper fuel to recommend to the consumer.

Assignment:

1. Read the following pages concerning selecting tractor and power-equipment fuels.

2. Identify the types of fuels used in your community in farm tractors by type, octane or cetane number and compression ratio.

3. Answer the questions in the Question Manual and turn in by__________.
(Suggested time allotment for this assignment: 2 to 5 hours.)

References:

X. Petroleum and Petroleum Products - Sales and Services, The Center for Research and Leadership Development in Vocational and Technical Education, The Ohio State University, Columbus, Ohio. (Following)

A. Color filmstrip, "Selecting and Storing Tractor Fuels and Lubricants." Southern Association of Agricultural Engineering and Vocational Agriculture, Athens, Georgia.

B. Motor Gasoline Additives and Their Functions, Ethyl Corporation of America, New York, New York.

Petroleum and its products are handled by many agricultural supply businesses and its distribution to farmers performs a much needed service. Because of this, there is a limited, but definite, need for persons either in sales or service occupations. Unless a business is unusually large, retail sales are carried on by non-specialists and orders for delivery are handled as a part of the general work load. The jobs of delivering to and servicing farmers as well as operating any storage facilities usually require men with some experience rather than young men just graduating from high school.

Very few agricultural supply businesses, except in some midwestern states, operate service stations comparable with those of the major oil companies. In most states, young men must be at least 18 years of age before they can secure a license to operate a tank truck, and there is practically no need for a "helper." Company policy may preclude riding as an observer. However, the willingness of rural youth for hard work, their reputation for reliability, and their ability to speak the farmers' language, gives them an advantage when being considered for employment as salesmen, or in some cases, as driver-salesmen.

The major portion of the petroleum business in a farm supply center is in products delivered to the farm such as gasoline, heating oil, and lubricants. Store sales are largely confined to kerosene, oils, lubricating greases and accessories. While the ability to drive a truck properly is often a major consideration for employment, the eventual value to the company and the amount of individual earnings will depend upon the individual's sales ability and the rapport he establishes with his customers. This unit emphasizes the sales and service aspects of the delivery of petroleum products to the farmer and retail sales work in the farm supply store.

An informal survey of the opportunities for employment in this field with the class will be a good way to introduce the unit. The students should immediately become aware that they cannot hope to become deliverymen servicing farmers until they are mature enough to assume the responsibility associated with such a job. They will not be driving a large truck loaded with potentially explosive products, and making recommendations as a business man immediately upon graduation from high school.

State research studies to supplement the local survey may be helpful in identifying the opportunity for employment in concerns handling petroleum products. It is entirely possible that the potential for employment in this particular area of agricultural supply - sales and service occupations may not justify the teaching of this unit on the high school level. In that case, selected area vocational schools may provide the training at the post-high school level for students who have a positive interest in becoming outside salesmen to meet the needs of the farm supply business.

At this point it would be helpful to identify the occupational title of workers in the petroleum area of agricultural supply occupations. In the current edition of the Dictionary of Occupational Titles all workers are included under the petroleum industry. However, in the revised edition soon to be available, it is understood that a different method of grouping will be followed. The October, 1964, draft of The Occupational Classification Structure for the revised Dictionary of Occupational Titles[1], indicates a classification for "Salesmen and salespersons, fuel and petroleum products."

Hoover, in his Handbook of Agricultural Occupations[2] lists the title "Truck Driver for a Rural Gasoline and Oil Distributor," which seems to accentuate the delivery and service aspect and plays down the importance of sales. However, in the career brief, the author indicates that although the driver loads his truck, makes deliveries, prepares sales slips and keeps records, he is also a salesman and works to establish good customer relations and to secure new customers. It will be helpful for the teacher and his students to go over this career brief to be found on page 130 of this handbook to see how the information applies to the local situation. This information is presented under the headings of: (1) Description and Nature of Work, (2) Working Conditions, (3) Educational and Personal Qualifications, and (4) How to Enter and Advance in the Occupation.

Practically all driver-salesmen operate under some kind of an incentive plan which rewards the individual who has initiative, ability to learn, and ability to sell his services as well as his product. A person who is content to remain a truck driver or product delivery man will make a satisfactory living. The individual who is willing to develop his sales technique to the level where his volume increases and the route shortens may develop the job into a lifetime career at a higher income.

Advancement may be from a route man to a full-time outside salesman or directly to petroleum manager for a farm supply center or petroleum distributor. Some individuals may have the ability and capacity to progress in management to assistant and then to general manager of an agricultural supply business. A few individuals may establish their own business, buying wholesale and delivering to retail customers on the farm or in rural communities. Since this involves a tremendous investment in storage facilities and trucks, this person is probably better off working for a company for several years rather than attempting an individual business which is under-capitalized.

The occupational title of Petroleum Engineer pertains to the professional field of activity for which a college degree is necessary. The title of Petroleum Specialist growing out of the research study now in progress at the National Center for Vocational and Technical Education envisages technical activities of a sub-professional nature not requiring a B.S. degree, but for which post-high school training would be necessary. While it would be possible for a high school graduate to advance from driver-salesman to a petroleum specialist by additional training, this unit considers only the competency required of a driver-salesman or inside salesman.

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[1] Dictionary of Occupational Titles, Volume II (Washington, D.C.: U.S. Government Printing Office, U.S. Department of Labor).

[2] Hoover, Norman K. Handbook of Agricultural Occupations (Danville, Illinois: The Interstate Printers and Publishers, Inc.) 254 pages.

There is limited opportunity for working initially as a helper and eventually as the person responsible for the delivery and installation of storage tanks to farms. This is usually done by someone other than the driver-salesman, since it requires a different kind of truck and usually requires more additional time than a man with a full schedule has available. However, small businesses or drivers with routes which do not require full time might combine delivery or service of the tanks with normal deliveries.

After the class understands the general nature of the work and the possibilities for employment, the next step in the introduction of the unit would be to develop a list of the understandings, abilities, and skills they would need for employment. This can start with the simple question, "What do you need to know, or be able to do, in order to become a petroleum driver-salesman?" The students' answers can be listed on the chalkboard as they give them, and then re-worded into the competencies which may be stated as follows:

I. To be able to select lubricating oils correctly

II. To be able to select and store gear oils, greases, and hydraulic oils correctly

III. To be able to select tractor and power equipment fuels correctly

IV. To be familiar with other products usually available to farmers through the salesman of petroleum products

V. To understand the design and placement of proper storage facilities for fuels on farms

VI. To understand the proper selection and storage of heating oils

VII. To understand and apply the safety laws and regulations pertaining to the delivery and storage of petroleum products

VIII. To understand the contractual relationship of the company to the delivery driver and the driver to the customer

IX. To be able to meet the requirements for a chauffeur's license and for operating a truck carefully and safely

X. ________________________________(The class or teacher should add to this list as they see fit.)

Since no specialized inside salesperson in petroleum products will be needed in the usual farm supply store operation, the teaching material of the unit is directed primarily toward the driver-salesman. However, all inside salespersons should be familiar with each of the competencies and as well qualified as the driver-salesman in competency No. III, competency No. IV, and competency No. VI. These are the policies concerned with lubricating oils, gear oils and greases, and accessories such as tires.

While it is not intended that this unit be used for the training of filling station attendants, achievement of some of the competencies will qualify an individual in these products regardless of where he works. Competencies I, III, IV and VI pertain to tractor fuels, lubricating oil, gear oils and greases, and other products available to farmers. In the same way, the competencies regarding storage facilities and safety, which are No. II and No. VIII are applicable to filling station attendants although they are written for farm delivery personnel.

Success in Petroleum Products - Sales and Service can be achieved if the farmer can be persuaded to start, and continue to use your products.

To do this you must (1) know what you have to offer, (2) discover what the farmer needs, (3) arrange for ordering and delivery in the most efficient manner and (4) build confidence in the customer that you are knowledgeable and reliable in meeting his needs. If you can do this, he will stay with you rather than try your competitors.

Competencies to be Developed

I. To be able to select tractor and power equipment fuels correctly

Subject Matter Content

The major source of income to the driver-salesman is from delivering tractor fuels to farmers. He has almost as great a stake as the farmer in being sure that the right fuel is used for a given tractor. A poor recommendation, or a mistake in delivery, might lose a customer and cut the volume which helps determine the paycheck.

Today's tractors are designed to operate best on one type and grade of fuel. In the operator's manual, the manufacturer is specific as to the fuel to use, and farmers should read these manuals and follow the recommendations. However, some farmers discard the manual soon after receiving it and tend to forget it, especially if they have several different tractors on their farms. Operator's manuals rarely accompany a used tractor when it changes hands, and the new owner expects that the deliveryman will know the type of fuel he should use. Most major oil companies provide their drivers with handbooks or reference sheets so they can be accurate in recommending the exact fuel which should be used with every model of tractor. Production and distribution of these sheets involves considerable expense which is justified only if the driver uses the information to promote his sales with farmers.

Students may have acquired a general knowledge of fuels for tractors from other high school courses, particularly vocational agriculture. It is suggested that the teacher determine how deeply he should go into the subject of tractor fuels before finalizing his teaching plan for this competency.

Tractor fuels are treated under modules 14, "Gasoline Tractor Engine Systems," and 15, "Diesel Engine Systems," of the course outline for AGRICULTURAL MACHINERY - Sales and Service Occupations. This is available from The Center for Vocational and Technical Education, The Ohio State University, 980 Kinnear Road, Columbus, Ohio, 43212. However, it is believed that the following brief presentation will assist the teacher of this course in his specialized treatment for driver-salesman and also serve as a review outline for students whose competency has been ascertained previously.

1. Selecting fuel for gasoline tractors

More tractors use gasoline than any other type of fuel, even though it costs more per gallon, contains less energy per gallon, and gasoline engines run at higher speeds with increased resulting wear. Kerosene, "distillate" and other lower-grade fuels can be successfully used in tractors and have relatively more energy in them, but their popularity has decreased as the spread in prices has decreased. This is due to the increase in the supply of gasoline as the result of improved techniques in refining, known as "catalytic cracking." It is now possible to make 57% of a barrel of crude oil into gasoline compared to 23% before the use of the "cracking" process. This has enabled refineries to keep the cost of gasoline down so that the price spread between gasoline and distillates is much less than five cents per gallon and gasoline can be economically used in tractors.

Along with improved refining came the increase in the development of anti-knock properties for gasoline which has a normal octane rating of 80-90. Manufacturers adjust their product according to the seasons of the year to give the most satisfactory service.

The regular grade of gasoline should be satisfactory for tractors regardless of the time of the year, as the reliable producer sees to it that it has three qualities:

a. Proper octane rating

b. Easy starting properties

c. Freedom from dirt, gum and foreign matter

The term "octane rating" or "octane number rating" is the method established by the American Society for Testing Materials (ASTM), for comparing the anti-knock qualities of fuels used in spark ignition engines. Zero was the value arbitrarily assigned to a fuel known as Normal Heptane, that has very poor anti-knock properties. When mixed with another fuel known as Iso-Octane, having excellent anti-knock properties, which was assigned the value of 100, it was possible to develop a graduated scale of anti-knock properties according to the proportion of Iso-Octane to Normal Heptane. When a given fuel is run in a test engine and the proportion of the two testing fuels is varied until the anti-knock quality is equal, the proportion of Iso-Octane determines the octane number. Thus, if a fuel being tested gives the same anti-knock performance as 80 parts Iso-Octane and 20 parts of heptane, the octane number is 80. While the anti-knock properties of gasoline have been improved by advances in the refining industry, it is always necessary to add some additional material to economically raise the octane rating.

The additive most usually used for this purpose is tetra-ethyl lead, although other lead compounds are now being used as physical mixtures of chemical compounds of lead. The physical mixtures of bad compounds are Tetra-ethyl lead, abbreviated TEL, and tetra methyl lead, abbreviated TML. The chemical compounds of lead are lead alkyls. The addition of very small amounts of these chemicals brings a marked improvement in the anti-knock qualities. Three milliliters of TEL per gallon of gasoline will raise the octane rating by 10.

Nothing is more provoking to the farmer than not being able to start his tractor in the winter, or having it be hard to re-start in the summer. To avoid these difficulties, the producer changes specifications or "blending" for the regular grade of gasoline at least twice and usually four times a year. This may be done to increase the "volatility" or tendency to evaporate more readily and promote easier starting in the winter when the weather is cold. This might also be done to reduce the volatility in the summer, which causes difficulty in re-starting after stopping, sometimes caused by volatile gases blocking the passage of gasoline through the lines.

The manufacturer does not usually inform the customer of the seasonal changes in blending, but the deliveryman can provide this information. He should advise his patrons in case they are stocking up too heavily at the time of the year changes are being made. It is never advisable to hold gasoline too long because of the loss of the "lighter ends" through evaporation. The farmer should not, therefore, carry a full tank of summer gas over for [illegible] in the cold months.

A farmer wants his tractor to start easily, run with normal power and continue to run dependably; if it does not, he immediately suspects dirt or water in the gasoline. When the valves "hold open," he suspects that gum has been deposited on the valve stems from poor gasoline. In reality, the manufacturer and distributor are not responsible for any of these conditions, but it takes a tactful driver-salesman to explain that the manufacturer is not at fault because of the following:

a. The precautions taken to keep dirt out of the gasoline until it goes into the farmer's tank

b. The precautions taken to control moisture in bulk tanks and removal of moisture, when necessary, before it is pumped into the delivery truck

c. The addition of chemicals during the refining process to prevent the accumulation of gum

d. That any dirt or moisture contamination probably occurred on the farm and can be controlled by proper storage tank installation and use. (See competency No. II of this unit.)

2. Selecting Fuels for Diesel Tractors

Diesel tractors have a higher initial cost, but are becoming increasingly popular because they provide more power from a cheaper fuel. They have a reputation for running on "anything" and were originally designed to use pulverized coal, but adequate performance is highly dependent on using the right quality of fuel.

Fuel injectors on diesel tractors replace the spark plugs and conventional carburetors of gasoline tractors and ignition takes place because the compression in the cylinder is great enough to increase the temperature to the degree that the fuel will burn spontaneously when sprayed into the cylinder. This is a high compression ratio of about 16:1 compared to 8:1 for gasoline tractors and 4:1 for the tractors that used kerosene. The average of 53 diesel tractors used in the 1960 Nebraska tests was 16.3:1. Although high compression means harder starting and usually noisier operation, it makes it possible to make better use of the energy in the fuel.

The manufacturer has certain qualities in mind when designing a particular engine with a specific compression ratio. Fuel recommendations are made in relationship to these qualities. The farmer should follow the recommendations of the manufacturer when selecting diesel fuel. The driver should be ready to help with recommendations if the farmer does not know which fuel to use or if the farmer is using the wrong fuel. In selecting a diesel fuel, the following should be considered:

a. The grade of the fuel needed

b. The "Cetane" rating

c. The sulfur and water content

Individual producers previously determined their own grades of diesel fuel, although they have recently been standardized by the American Society for Testing Materials (ASTM) into the two grades which have desirable combinations of fuel properties.

Number One diesel fuel is better for cold weather because it has a lower viscosity which allows easier starting, and contains somewhat fewer chemical impurities. This is commonly abbreviated as No. 1-D.

Number Two diesel fuel is slightly cheaper than No. 1-D, supplies more energy per gallon, and has a higher viscosity. The higher viscosity provides better lubrication of the injectors, but also causes harder starting in cold weather. Number two fuel is abbreviated as No. 2-D.

The standards for these two fuels set the minimum "cetane rating" which for diesel fuels is roughly equivalent to, but not identical to octane rating for gasolines. These standards also provide maximum limits on impurities such as water and sulphur. Refineries usually provide a fuel which exceeds the minimum standards, which a farmer can purchase according to the recommendations in the operator's manual and be confident that he is using the best fuel for his tractor.

In diesel engines, "knocking" is caused by the fuel igniting too slowly. It should burn as soon as injected into the cylinder, and if there is much delay in burning, the fuel overloads the cylinder until it eventually burns with explosive force. This not only causes excessive noise but causes more wear on engine parts. This delayed burning in diesels is the exact opposite of the cause for knocking in gasoline tractors which is caused when the air-fuel mixture burns too rapidly, resulting in pre-ignition.

The octane rating system cannot be used for diesel fuels, since good quality diesel fuels provide for early spontaneous combustion, which is exactly opposite to what is wanted in good-quality gasoline. The rating scale for diesel fuel of 0 to 100 and the method of testing established by the ASTM is similar to that for gasoline, but different test-fuels are used, including cetane.

A cetane rating of from 40 to 60 is suitable for diesel tractor fuel and since ASTM specifies a minimum cetane rating of 40, both fuels fall within this range. The farm tractor manufacturer not only indicates the grade but also recommends a minimum cetane number. As with gasoline, the driver-salesman should know the cetane number of each of the diesel fuels he sells, and should be prepared to check that they are suitable for the particular make and model of tractor owned by the farmer.

Next to the cetane number, a farmer may want to know the amount of sulphur and water contaminants in the fuel. Sulphur burns in the combustion process and combines with moisture to form acids which can cause rapid wear and assist in the formation of deposits. These deposits occur in the cylinder and on pistons and rings. Water by itself may cause rust and interfere with the lubrication of the injectors. It collects on the filter screens and will freeze in cold weather. ASTM standards permit more sulphur in No. 2-D fuel than No. 1-D, and farmers should see that harmful effects are counteracted by proper selection of lubricating oils.

See competency number III of this unit.

3. Selecting Fuels for Two-Fuel Tractors

Tractors which start on gasoline and then switch to a lower-grade fuel for running are referred to as "two-fuel" tractors and were very popular at one time. They were less expensive to purchase than diesels and would use kerosene, distillate tractor fuel, number one fuel oil, and even furnace oil, but they have largely been discarded when worn out, or converted to use gasoline.

There are few tractors operating today on two fuels, therefore distributors rarely handle the variety of fuels that may be used for this purpose. Gasoline and kerosene should not be mixed in an attempt to provide a "grade" of fuel. Any given grade of farm tractor fuel is a chemical compound and not a physical mixture.

4. Selecting Fuels for LP-Gas Tractors

Liquified petroleum gas (abbreviated LP or LPG) must be kept under pressure at all times in order to keep it in a liquid form until introduced into the cylinder. This requirement for high pressure storage tanks at the terminal, and high pressure tank trucks for delivery usually causes LP-gas to be handled through different channels than gasoline or diesel fuels. The same high pressure tank can be used for crop drying and household heating or tractor fuel. The distributor of LP-gas also provides portable tanks on an exchange basis to provide gas heating for cooking, brooding, water heating, and other uses when natural gas is not available.

A tractor especially equipped to use LP-gas means a mounted pressure tank to replace the gasoline tank, and a compression ratio higher than 8.5:1. It is possible to convert existing tractors to the use of LP, but this is usually done in a specialized shop rather than by the farmer. Modification is relatively expensive when the compression must be changed, but with this the economy of using LP-gas is improved.

Some distributors prefer to own the large 500 to 1000 gallon tanks rather than sell them to the farmer. This permits better control and fewer operating or safety hazards. A modest "lease fee" is charged at the time of installation, which hardly covers the labor and fittings involved.

The cost for LP-gas decreases materially as the amount consumed per year increases. For this reason the farmer who uses LP-gas for tractor power usually uses it for crop drying, household heating, and other purposes. One company's rates in 1965 were:

1400 gallons or less per year---17¢ per gallon
1400 " to 2000 gallons----16¢ per gallon
2000 " to 3000 gallons----15¢ per gallon
Over 3000 gallons per year------14¢ per gallon

While the use of LP-gas for farm tractors is increasing, the farmer must depend on the distributor for the quality of the product. The reliable distributor makes sure the product he secures from the refinery is relatively free from sulphur and other contaminants which might cause difficulties including regulator failures, filter plugging, and other problems.

LP-gas is no more dangerous than gasoline when properly handled. Distributors make every effort to properly instruct the farmer in operation of the tanks and equipment, especially in refilling operations. Storage tanks are all fitted with safety valves to permit burning rather than exploding in cases of improper handling. However, even these will not suffice for careless operation.

The following summary of fuels may be helpful:

Type of Fuel (Spark Ignited)	Octane Rating	Approximate Compression Ratios	Critical Points
Kerosene or No. 1 fuel oil	0-30	4:1	supplies lots of power-relatively high priced
Farm tractor fuel	35-70	4:7-1	replaces the old "distillate," "all fuel," "power fuel," etc.
Low grade gasoline	70-75	5-6:1	can be used, but poor economy for low compression engines using tractor fuel
Regular grade gasoline	80-93	7-8:5-1	standard for most tractors
Premium grade gasoline	95-105	9-10:1	suitable for automobiles
Liquid petroleum:			
Butane	95-100	7:8-1	limited use on farms because of higher cost; mostly used in the chemical industry
Propane	110-115	8:75-1	supplies economical power because of higher compression even though it contains less energy per gallon

Diesel fuel:	Cetane Number	Compression Ratio	Critical Points
No. 1-D	40-60	14-20:1	use in winter for easier starting
No. 2-D	40-60	(average 16:1)	requires different lubrication oil because of more sulphur

5. Gasoline Additives

Materials added to fuels or lubricating oils which improve performance or increase economical yields at the refinery are referred to as "additives."

Major oil companies can produce a good gasoline with fair anti-knock properties through regular refining processes, but the yield would be so small that the gasoline would be too expensive. It is much cheaper to secure greater yields from crudes and at the same time create a higher performance fuel by the addition of additives. However, additives will be taken up under each product rather than being considered as a separate subject.

Small amounts of additives are used, and their cost is relatively cheap compared to their effect and the improved quality of the resulting product. All refineries use them and most gasoline sold today contains at least six or seven additives.

(Note to teachers: It is not necessary to go too deeply into the related chemistry of additives with high school classes, but post-high school students should know the names of the compounds and know a little of the chemical reactions involved.)

a. Anti-Knock Additives

The first additive used was tetraethyl lead (TEL) introduced in 1932 to combat the knocking of ordinary gasoline due to pre-ignition. It is still the major anti-knock additive, although today refineries use other lead compounds and mixtures. No one knows for sure how TEL and other lead compounds control or prevent knock, although extensive research is going on. We do know that gasolines are made up of many hydrocarbons with slightly different burning rates. When these hydrocarbons are compressed and heated in the presence of air, as in the cylinder, they react rapidly. When ignition takes place, the flame spreads rapidly in the combustion chamber and further compresses and heats the fuel-air mixture ahead of it. Some of the hydrocarbons in the unburned part of the gas may undergo chemical reactions prior to normal combustion. The products of these reactions may self-ignite and burn at a rate 5 to 25 times the normal combustion of the rest of the gas-oil mixture. This rapid burning sets up a high-frequency shock wave that produces the sharp metallic "knock."

A knocking engine gives less power with resulting poor fuel economy. Severe and continuous knock decreases wear and life of valves, plugs, pistons and bearings.

Present evidence indicates that a fine dispersion of solid lead oxide or lead metal is what prevents or overcomes the knock by slowing down the reaction rate.

Tetra methyl lead (TML) increases the octane number of some modern gasolines more than TEL and does a better job of overcoming the knock resulting from fuel segregation and manifold lag. When this happens, the more volatile fractions with lower octane numbers fill one or more cylinders and "knock" while others receive charges with higher octane numbers and more anti-knock additives than are necessary. TML, being more volatile than TEL, tends to distribute itself more uniformly to all of the cylinders when mixed with gasoline. The process by which TML prevents knocking is probably the same as for TEL.

Mixed lead alkyls were developed to provide an additive intermediate between TEL and TML both in composition and volatility. This was accomplished by enabling TEL and TML to react in proper proportions and under proper conditions.

Custom blends or mixtures of TEL and TML are also available for providing any degree of volatility between TEL and TML.

The customer is more interested in the result of the anti-knock additive than its physical or chemical composition. The salesman should have some overall knowledge of the kinds of anti-knock additives and how they work, but the customer and the salesman must depend on the producer to use the proper additive in the proper amounts.

b. Scavenger Additives

It is characteristic of additives that as soon as one is added to improve an existing condition, another must be added to counteract the original additive. For this reason, scavengers are added to leaded gasoline to remove the non-volatile combustion products resulting from the burning of the anti-knock additive. Ethylene dibromide and/or dichloride are added to change combustion products into forms which vaporize easily from the hot engine surfaces. This is a major reason why "white" gas is preferred for gasoline lanterns. Such scavengers are always included whenever a lead compound is used for antiknock purposes.

c. Promoter Additives

Another additive to an additive is a complicated manganese compound which greatly improves the antiknock characteristics of leaded gasoline when used in very small quantities. This manganese compound is used in most gasolines.

d. Deposit Modifier Additives

Deposits in the combustion chamber can cause preignition by glowing at temperatures high enough to ignite the incoming fuel-air mixture. Phosphorus or boron is added to gasoline to change the deposits to forms which have both higher electrical resistance and more resistance to glow. The same phosphorus or boron additives prevent deposits on the spark plugs during light duty or low temperature operation of an engine. This results in cleaner spark plugs and more reliable performance.

e. Antioxidant Additives

Gum formation is caused by the oxidation of some of the unstable hydrocarbons in gasoline. This gum results in varnish-like deposits which clog fuel lines, carburetor jets, intake manifolds, and buildup on intake valve stems, causing them to stick. It is influenced by many factors, including the length of the storage period. Phenol compounds are used as antioxidants and are added to gasoline to retard this gum formation. Because the gum formation still occurs, but at a slower rate, gasoline should not be stored over six months.

f. Metal Deactivator Additives

Copper contamination results during gasoline manufacture and storage in small amounts and results in increased oxidation. This situation is overcome by adding small amounts of "chelating agents" which stabilize the copper compounds and overcome the effect of copper contamination.

g. Anti-Rust Additives

Hydrocarbon soluble compounds are used, which coat metal surfaces with a thin protective covering, and thus prevent water in the fuel from coming into direct contact with metal surfaces. These agents, usually fatty acids, inhibit rust and carburetor jet clogging. These additives also help to prevent carburetor icing and avoid buildup of deposits within the carburetor.

h. Anti-Icing Additives

Farmers usually blame ice in carburetors on water in the gasoline. This may happen when storage tanks are not properly handled to prevent accumulation of water due to condensation. However, it is frequently caused by the freezing of the water vapor in the air which is drawn into the carburetor independently of the moisture in the gasoline. This may happen when a cold motor is started with atmospheric conditions of above 65% relative humidity and a temperature of 30 to 50 degrees Fahrenheit. The fuel vaporizing in the carburetor creates a cooling effect which in turn causes the mosture in the air to condense and form ice in the carburetor. At idling speeds, ice can bridge the small gaps in the throttle mechanism thus cutting off the air supply and stalling the engine. Carburetor icing can also take place during constant speed operation resulting in "missing" because the mixture is too rich. This rich mixture occurs when the ice has built up in the venturi and acts as a choke.

Anti-icing agents may be either freezing point depressants or surface-active agents. Freezing point depressants act in the same manner as anti-freeze acts in radiators to prevent the formation of ice. They are usually alchols or glycols. Surface-active agents coat the ice particles after they are formed and prevent them from sticking together. Phosphate compounds serve as surface-active agents and also as anti-rust agents.

i. Carburetor Detergent Additives

Deposits in the carburetor sometimes cause rough idling or stalling resulting in poor performance and poor fuel economy. These deposits result from the non-volative fuel components and contaminants from crankcase fumes being drawn in through the air cleaner. These deposits interfere with the normal flow of and with air-fuel ratios. Detergents are added to most fuels to prevent the buildup of deposits and reduce those already in place. The usual detergent additives are phosphate compounds which work because of their surface-active properties.

j. Upper Cylinder Lubricant Additives

A number of products were developed and are still sold at filling stations to prevent piston ring and valve sticking. These are usually unnecessary in today's gasolines which have these additives incorporated into them at the refinery. The upper cylinder lubricants are usually light mineral oils or naphenic distillates of low viscosity which function by dissolving the deposits and rinsing them out during engine operation.

k. Dye Additives

Dye is included in leaded fuel to identify the use of such fuel for motor fuel only and not for heating or cleaning purposes. They may also be added to promote sales appeal or identify the product or the grade of a product. All dyes are soluble in petroleum fuels, and vary in intensity according to the refiner's standard. They have nothing to do with the performance of a gasoline.

Some states require that gasoline sold for off-highway use be dyed a different color than that used by vehicles on the roads. In some states, misuse of the dye is a serious offense.

Suggested Teaching-Learning Activities

1. Write out what you know in your own words concerning:

   a. Tractor motor functioning fuels

   b. The nomenclature of internal combustion engines. This should be done before starting to answer the study questions.

It is vital that a salesman know at least as much about the mechanical functioning of the power equipment for which the fuel will be used as the farmer. Nothing will cause a loss of confidence faster than for a salesman to indicate his lack of knowledge by making an inaccurate or inappropriate remark.

2. Visit a refinery so you can visualize the process which starts with crude oil, and is capable of producing so many products by the refining process with a high degree of flexibility. In place of this, visit or have brought to school a display of a major oil company, showing the variety of products available, and including samples.

3. Identify the type of tractor fuels used on a large farm in the community by type, octane, or cetane number and compression ratio. Amplify, if necessary, by including the information pertaining to their neighbors' tractors in order to have all types presented.

4. Visit a laboratory equipped for determining octane numbers or cetane numbers and observe the testing process. Alternatively, try to get a representative of the laboratory to visit the school and demonstrate the testing process.

5. Role-playing can be used to bring out the relative advantages of one type of tractor fuel over another, with one person representing a farmer and another a salesman for each type of fuel.

6. Use a film or film strip to show the use of "additives" in gasoline or have a representative of a major oil company present this orally to the class, exhibiting samples of the materials used.

7. The suggested time allotment for this unit is:

Class instruction---------------4 hours
Field trip or laboratory--------1 hour

Total--------5 hours

Suggested Instructional Materials and References

Instructional materials

1. "Selecting and Storing Tractor Fuels and Lubricants," color filmstrip, Southern Association of Agricultural Engineering and Vocational Agriculture, Athens, Georgia.

2. Films or filmstrips available from major oil companies.

3. Samples or charts available from major oil companies.

References

1. Selecting and Storing Tractor Fuels and Lubricants, Southern Association of Agricultural Engineering and Vocational Agriculture.

2. Motor Gasoline Additives and Their Functions, Ethyl Corporation of America, New York, New York.

3. Drower, Mezera, and Nast, LP Gas Engine Fuel--To Be or Not To Be. . .That is the Question, International Harvester Company.

4. Publications from major oil companies.

Suggested Occupational Experiences

1. Working in any capacity that brings the student into contact with the different kinds of motor fuels and the people who buy or sell them. This may be at the terminal, riding with a driver-salesman, or in a retail filling station.

2. Working as a tractor operator preferably on a farm which has more than one tractor and uses more than one kind of fuel.

3. Working in a situation where liquid petroleum gas is used for brooding or crop drying.

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STUDENT WORKSHEETS

Agricultural Supply, Sales, and Service Occupations

Petroleum and Petroleum Products Sales and Service Occupations

Part V

(Supplement to Publication No. 9)

VT010311

Assignment
Worksheet No. 1

SELECTING TRACTOR AND POWER EQUIPMENT FUELS

True-False

Directions: The following statements are either true or false. If the statement is true, draw a circle around the letter "T". If it is false, draw a circle around the letter "F".

T F 1. More tractors use diesel than any other type of fuel.

T F 2. The regular grade of gasoline should be satisfactory for tractors regardless of the time of the year.

T F 3. The farmers need not worry about carrying over a tank filled with summer gas for use in the cold winter months.

T F 4. Diesel tractors are becoming increasingly popular because they provide more power with a cheaper fuel.

T F 5. Ignition takes place in diesel tractors because the compression in the cylinder is great enough to increase the temperature to the degree that fuel starts to burn spontaneously when sprayed into the cylinder.

T F 6. Each refinery presently determines its own grades of diesel fuel.

T F 7. A cetane rating of from 40 to 60 is most suitable for fuels used in diesel tractors.

T F 8. Tractors which start on gasoline and then switch to a lower grade fuel for running are referred to as "two-fuel tractors."

T F 9. The converting of fuel burning tractors to the use of LPG is usually done by the farmer himself.

T F 10. The cost for LP-gas decreases materially as the amount consumed per year increases.

T F 11. All refineries today use additives and most gasoline sold contains at least six or seven additives.

T F 12. The customer is more interested in the exact physical or chemical composition of an anti-knock additive than in the result it will produce.

T F 13. The cost of TML and other anti-knock additives is less than TEL.

14. It is in the tradition of additives that as soon as one is added to improve an existing condition, another must be added to further improve the result or effect of the original additive.

Completion

Directions: Fill in the blank(s) in each statement with the word(s) required to complete the sentence correctly.

1. The American Society of Testing Materials (ASTM) (an organization for comparing the anti-knock qualities of fuels used in spark ignition engines) establishes the term ____________ ____________ or ____________ ____________ ____________ for fuels.

2. Today approximately _____ percent of a barrel of crude oil can be refined into gasoline.

3. Refineries are able to break down crude oil into gasoline by a process called ______________ ______________.

4. Anti-knock properties are developed in accordance to the proportion of ________ ____________ to normal heptane.

5. The material most commonly used to raise the octane number in gasoline is ________________ ________________.

6. In order to prevent "vapor lock" in the summer and hard starting in the winter the producer deliberately changes ____________________ or ____________________ for the regular grade of gasoline at least twice and usually ____________ times a year.

7. As stated in question 6, this process is done to increase the ____________________ or tendency to evaporate more readily.

8. Spark plugs on conventional gasoline tractors are replaced by ______________ ____________________ on diesel tractors.

9. The compression ratio for diesel tractors is about ________ compared to a __________ ratio for gasoline tractors and _______ ratio for the old-fashioned tractors that used kerosene.

10. Number one diesel fuel (no 1-D) is better for cold weather because it has a ________________ __ ______________ and contains somewhat fewer ____________ ______________.

11. In diesel engines, "knocking" is caused by the ____________ ______________ too slowly.

12. The octane rating system ______________ be used for diesel fuels, since good quality diesel fuels provide for early ________________ ______ ________________, which is exactly opposite to what is wanted in good quality gasoline.

13. The higher the __________ number in diesel tractors, the more quickly a fuel will ignite upon entering the cylinder and the easier the tractor will start.

14. ______________ is sometimes used in diesels that are hard to start in cold weather.

15. Sulfur and water in diesel fuels are referred to as ______________.

16. The letters LPG stand for __________ __________ __________.

17. The difference between the storage of LPG and other fuels is that LPG requires __________ __________ __________ tanks.

18. While the use of LP-gas for farm tractors is increasing, the farmer must depend solely on the ______________ for the quality of the product he provides.

19. The ability to secure greater yields from crude oil and at the same time create a higher performance fuel may be done by the addition of other materials which are collectively referred to as ______________.

20. The first additive used as early as 1932 to combat the knocking of ordinary gasoline due to pre-ignition and is still a major anti-knock additive is ______________ ______________.

21. We know that gasolines are made up of many ______________ with slightly different burning rates.

22. ______________ __________ increases the octane number of some modern gasolines more than TEL and does a better job of overcoming the knock resulting from fuel segregation and manifold lag.

23. __________ ______________ of TEL and TML are available for providing any degree of volatility between TEL and TML.

24. ______________ additives are added to leaded gasoline to remove the non-volatile combustion products resulting from the burning of the anti-knock additives.

25. Phosphorus or boron is added to gasoline to change the chemical composition of __________ __________ deposits which cause surface ignition and spark plug fouling.

Listing

Directions: List the items called for in each of the following. Select your answers carefully.

1. Three disadvantages of using gasoline in tractors are:

   a.

   b.

   c.

2. The regular grade of gasoline is satisfactory for tractor usage because a reliable producer sees to it that it has three qualities. Name those three qualities:

   a.

   b.

   c.

3. A farmer wants his tractor to start easily, run with lots of power, and not stop suddenly after the usual sputtering and misfiring. He naturally blames the gasoline. How can a tactful driver-salesman explain to him the reasons that this is not the fault of the manufacturer or distributor? Give 4 precautions that are taken:

   a.

   b.

   c.

   d.

4. What are the three things that should be considered when selecting a diesel fuel?

   a.

   b.

   c.

5. Number two diesel fuel (no 2-D) is harder to start when used in tractors in cold weather, but has three advantages over No 1-D. Name these advantages:

   a.

   b.

   c.

6. The two reasons that "two-fuel" tractors have lost popularity in the last few years are:

   a.

   b.

7. Why are LP-gas storage tanks fitted with safety valves?

   a.

8. Describe the following additives and give their chief function:

   a. Anti-icing additive--

   b. Anti-oxidant additives--

   c. Anti-rust additives--

   d. Dye additives--

   e. Metal deactivator--

   f. Carburetor detergent additives--

   g. Upper cylinder lubrication additives--

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TEACHERS KEY

Agricultural Supply, Sales, and Service Occupations
Petroleum and Petroleum Products Sales and Service Occupations
Part V

(Supplement to Publication No. 9)

Teachers Key
Assignment
Worksheet No. 1

SELECTING TRACTOR AND POWER EQUIPMENT FUELS

True-False

1. F
2. T
3. F
4. T
5. T
6. F
7. T
8. T
9. F
10. T
11. T
12. F
13. F
14. T

Completion

1. Octane rating, cetane number rating
2. 57%
3. catalytic cracking
4. iso octane
5. tetraethyl lead
6. specifications, blending, four
7. volatility
8. fuel injectors
9. 16:1, 8:1, 4:1
10. lower viscosity, chemical impurities
11. fuel igniting
12. cannot, spontaneous combustion
13. cetane
14. ether
15. contaminants
16. Liquified petroleum gas

17. High pressure storage

18. Distributor

19. Additives

20. Tetraethyl lead

21. Hydrocarbons

22. Tetramethyl lead

23. Custom blends

24. Scavenger

25. Combustion chamber

Listing

1. a. Costs more per gallon than diesel fuel
   b. Gasoline contains less energy per gallon
   c. Gasoline engines must run at a higher speed thereby increasing wear

2. a. Proper octane rating
   b. Easy starting properties
   c. Freedom from dirt, gum and foreign matter

3. a. The precautions taken to keep dirt out of the gasoline until it goes into the farmer's tank.
   b. The precautions taken to control moisture in bulk tanks and removal of moisture, when necessary.
   c. The addition of chemicals during the refining process to prevent the accumulation of gum.
   d. Any dirt or moisture contamination probably occurred on the farm and can be controlled by proper storage tank installation and use.

4. a. The grade of fuel needed
   b. The cetane rating
   c. The sulfur and water content

5. a. Costs less
   b. Supplies more energy per gallon
   c. Provides better lubrication of the injectors

6. a. Gasoline costs about the same as distillate
   b. More gasoline is available as a result of improved refining techniques

7. a. To permit burning instead of exploding in cases of improper handling.

8. a. Anti-icing additive--
   (1) may be alcohols or glycols
   (2) lower the freezing point of water
   (3) prevent ice crystals from sticking together

   b. Anti-oxidant additives--
   (1) phenal compounds
   (2) retards gum formation caused by the oxidation of unstable hydrocarbons

   c. Anti-rust additives--
   (1) fatty acids
   (2) coat metal surfaces with a protective covering to prevent the formation of rust

   d. Dye additives--
   (1) added to leaded fuel to identify the use of fuels
   (2) soluble compounds are used

   e. Metal deactivator--
   (1) additive which stabilizes copper compounds and prevents contamination by these compounds

   f. Carburetor detergent additives--
   (1) phosphate compounds added to fuels to prevent the formation of deposits in the carburetor

   g. Upper cylinder lubrication additives--
   (1) light mineral oils added to fuels to prevent piston ring and valve sticking

Roland Peterson

ED035773

UNIVERSITY
OF
NEBRASKA

COORDINATORS GUIDE

A SYLLABUS FOR
GENERAL RELATED INSTRUCTION
FOR OFF-FARM AGRICULTURAL AND
DIVERSIFIED OCCUPATIONS IN
NEBRASKA

Prepared and Compiled by
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Publication No. 2 — 1965
THE NEBRASKA AGRICULUTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
Division of Vocational Education
Nebraska State Department of Education
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FOREWORD

The Guidelines and Procedures issued by the Nebraska State Board for Vocational Education provides for programs of Diversified Occupations, which includes one year of Related Instruction. This syllabus has been prepared to aid teacher-coordinators in Nebraska to provide instruction in the General Related instruction phase of the off farm and Diversified Occupation programs. Although the materials were prepared as part of the Nebraska Agricultural Education Project, which provides for Related Instruction for students preparing for agricultural occupations other than farming (off-farm agricultural occupations), the materials will be usable in any diversified occupation program offered in Nebraska.

The material is intended to be covered completely in the classroom. It is designed to provide approximately 90 hours of instruction during the school year, or one half of the related instruction course, and is to be integrated with the specific related instruction offered during the school year.

The General Related units have been organized as follows:

1. An introduction to each unit, which is designed to arouse interest and stress the importance of the unit topic.
2. A definite student assignment.
3. A list of references for the student.
4. A list of discussion questions based upon the reading assignment.

This syllabus, together with the basic study guides and references, are recommended for use in Diversified Occupation programs and in the preparation of students for off-farm agricultural occupations in the schools in the Nebraska Agricultural Education Project in Nebraska.

Cecil E. Stanley
Assistant Commissioner of Education
State Board for Vocational Education
State of Nebraska

ACKNOWLEDGMENTS

Special acknowledgement is due Mr. Carl O. Rodery, Consultant to the Department of Agricultural Education, University of Nebraska, for the preparation of this syllabus for use in conducting the General Related instruction program of Diversified Occupations, including the preparation of students for entry into agricultural occupations other than farming. Mr. Rodery is an experiences coordinator of Cooperative Occupational Experience programs in Missouri, and, starting 1 August 1965, will assume the position of Assistant Principal at Hazelwood Junior High School Hazelwood School District, Hazelwood Mo.

This syllabus has been designed to coordinate and facilitate the use of the study guides entitled Student Manual for Occupational Relations published by the University of Minnesota Bookstore, St. Paul, Minnesota, and General Related Study Guide published by the Industrial Education Department, University of Missouri, Columbia, Missouri. The syllabus is designed to complement, not replace, the publications, and acknowledgement is due Warren G. Meyer of the University of Minnesota and the Industrial Education Department of the University of Missouri, from which materials for the present publication were adapted.

John K. Coster

TO THE COORDINATOR

In the field of education, the instructor and his methods of procedure play a vital role in determining student success. Toward this goal of student success, a general related study guide and a coordinator's manual have been provided. Flexible utilization of this material is suggested to the teacher coordinator.

It is suggested that basic content be develped with the initial five units beginning the school year; unit IX be taught during the income tax pay period, and; Unit XVII be covered at the conclusion of the year. The teacher coordinator may then decide when and in what manner the remaining assignments are to be presented.

This course of study may not meet all the requirements for comprehensive learning experience for each student in the general related instruction, but it is our belief that it can provide a basic foundation of knowledge and understandings. The group dynamics discussion technique is recommended for the development of these general related units.

Satisfactory instruction of the general-related and the specific-related units can be achieved as follows:

1. Allot specific days of the week or month to each unit.
2. Complete a unit of general-related material without interruption and assign an equal number of days to the specific-related units.
3. Refer to the Coordinator's Guide for Occupational Relations, University of Minnesota, for additional instructional assistance.
4. Vary instructional techniques and methods.

REFERENCES USED IN THE GENERAL RELATED STUDY GUIDE

It is recommended that the following references be purchased in quantity not less than one for each two students.

1. Chapman, Paul W., Your Personality and Your Job, Science Research Associates, 57 West Grand Ave., Chicago 10, Illinois, 1944, $0.50

2. Humphreys, J. Anthony, Helping Youth Choose Careers, Science Research Associates, 57 West Grand Ave., Chicago 10, Illinois, 1950, $0.50

3. Keily, Helen J. and Walters, R. G., How to Find and Apply for A Job, South-Western Publishing Co., 5001 West Harrison Street, Chicago, Illinois 60644, 1960, $1.20, (Stock No. K04)

4. Schacter, Helen, Getting Along With Others, Science Research Associates, 57 West Grand Ave., Chicago 10, Illinois, 1960, $0.50

5. Social Security Administration, Your Social Security (35a), U. S. Department of Health, Education and Welfare, Room 400, 121 N. 13 Street, Lincoln, Nebraska 68508, Free (Order 1 Social Security Teaching Kit per teacher) Free.

6. University of Minnesota, Student Manual For Occupational Relations, Nicholson Hall Bookstore, University of Minnesota, Minneapolis 14, Minnesota, 1959. $2.75

7. University of Missouri, General Related Study Guide, Department of Industrial Education, University of Missouri, Columbia, Missouri. 1960, $1.50

8. U. S. Treasury Department, Publication 19, Teaching Taxes, Personnel Training Director, District Office of Internal Revenue, Omaha, Nebraska, Free (Order after October 15, one for each student and one teachers kit).

9. Wilhelms, Fred T., and Heimerl, Ramon P., Consumer Economics, Principles and Problems, Second Edition, Gregg Publishing Division, McGraw-Hill Book Company, Inc., 4655 Chase Ave., Lincolnwood, Chicago 46, Illinois 1959, $4.48

10. Worthy, James C., What Employers Want, Science Research Associates, 57 West Grand Ave., Chicago 10, Illinois, 1950, $0.40

Supplementary materials which would be good for additional reading and assignments. These would make a good beginning for a classroom reference library.

Extension Service Bulletins, University of Nebraska, College of Agriculture (available at your local county extension office) Free single copies.

Nebraska Taxes
1. EC62-817A The Role of Government in Our Society

2. EC62-817B Public Services: Cost and Financing

3. EC62-817C Basic Principles of Public Finance

4. EC62-817D An Evaluation of the Major Taxes

5. National Association of Manufacturers Your Future, National Association of Manufacturers, 2 West 48th Street, New York 17, New York, 1959, $0.50.

6. Nebraska State Department of Labor, Nebraska Labor Laws, Lambert Eitel, Commissioner of Labor, State Capitol Building, Lincoln, Nebraska (Free).

Science Research Guidance Series Booklets cost $0.50 each. Order the following booklets from Science Research Associates, 57 West Grand Avenue, Chicago 10, Illinois.

7. Byrne, John and Byrne, Katharine, You and Your Abilities

8. Christensen, Thomas E., Getting Job Experience

9. Dreese, Mitchell, How to Get the Job

10. Gerken, C., Study Your Way Through School

11. Humphreys, Anthony J., Choosing Your Career

12. Packard, Vance, Do Your Dreams Match Your Talents

13. Wolffein, Seymour L., and Goldstein, Harold, Our World of Work

14. U. S. Department of Labor, Brief History of the American Labor Movement, Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1957, $0.35

Film Reference

The University of Nebraska films referred to in this guide may be ordered from:

Audiovisual Library
Bureau of Audiovisual Instruction
University Extension Division
University of Nebraska
Lincoln, Nebraska 68508

A sample order form can be found on the following page.

UNIT I
ORIENTATION

I. Key to Study Questions 4 Class Hours
 1-4 reference 1
 5-11 reference 2

II. Teaching Hints

1. Lead the class to develop a list of advantages of the DO program to the student such as the following list:

ADVANTAGES OF PART-TIME TRAINING PROGRAM TO THE STUDENTS

1. Improves the possibility of securing desirable full-time employment following graduation from high school.
2. Provides an objective program of study and learning by practical experience on a job, while you are attending school.
3. Promotes the development of business ability -- the acquiring of technical skills and job intelligence.
4. Provides an opportunity to earn while you learn.
5. Develops characteristics in the individual which lead to "promotion."
6. Develops appreciation of the manner in which academic studies "tie up" with real situations in the business world.
7. Parents, students, employers and the coordinator work together.
8. Learning proper work habits and attitudes is important for the cooperative program, in addition to, learning skills.

2. Buzz session for small groups on one or more of the following topics:
   1. What are some of the reasons that students enter the DO program?
   2. How can we advertise the DO program?
   3. What are the advantages of the learner-employer relationship in learning a job?

III. Suggested Visual Aids

1. Cooperative training in Diversified trades (26 minutes) Color $4.50 Rent
   This film shows the relation of cooperative training to the high school program and local industry, and shows how the program can fit into the training needs of a community. Visual Instruction Bureau, Division of Extension, University of Texas, Austin 12, Texas.

2. Earn Money While Going To School (11 minutes) $2.00 Rent.
   This film shows that part-time work is valuable in many ways: increasing responsibilities, understanding the relations between job work and school work, etc. University of Nebraska.

Roland Peterson

ED035773

UNIVERSITY
OF
NEBRASKA

STUDENT MANUAL

A SYLLABUS FOR
GENERAL RELATED INSTRUCTION
FOR OFF-FARM AGRICULTURAL AND
DIVERSIFIED OCCUPATIONS IN
NEBRASKA

Prepared and Compiled by
CARL O. RODERY

THE NEBRASKA AGRICULUTURAL EDUCATION PROJECT
Department of Agricultural Education
University of Nebraska
In Cooperation with
Division of Vocational Education
Nebraska State Department of Education
Lincoln, Nebraska

VT010311

This publication was prepared in furtherance of a project supported by a grant from the U. S. Department of Health, Education, and Welfare, Office of Education, entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming." The project was initiated by Professors J. K. Coster and H. W. Deems of the University of Nebraska, and has been designed DAVR Project No. 001-65, and Contract No. OE-05-85-020.

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UNIT I

ORIENTATION

The Diversified Occupations Program was probably explained to you before enrollment in this class. Yet, there are probably questions remaining in your mind about its operation.

These units have been compiled with the purpose of providing such information, in addition to, data concerning the benefits both parties will receive. You must acquaint yourself with this material because others will definitely call upon you to explain the program operation and the meaning of the term, "Diversified Occupations Education".

In this introductory unit, it is our purpose to assist you in obtaining an understanding of the nature, purposes and adjustment to the part-time vocational education program.

Assignment:

1. Read the following references.
2. Write a short paper on the topic, "Responsibilities of the Diversified Occupational Education."
3. Be prepared to discuss the following questions in class.

References:

1. University of Minnesota, Student Manual for Occupational Relations PP 1-6
2. University of Missouri, General Related Study Guide PP 7-13

Questions:

1. What is the meaning of the term "coordinator"?
2. For what reasons will your coordinator contact you on your job? Why will he confer with your employer?
3. What two types of related information will you be studying in class? How do these two types differ?
4. What part does the employer play in the cooperative program?
5. Of what value is the DO program in choosing a career? In training for a career?
6. Why is it so important to be able to get along with other people?
7. How can you assure yourself of adequate leisure time?
8. How can you be an ambassador of the DO program in your school and community?

9. Why is it not advisable for friends to visit you on the job?

10. Why, in this type of a program, is training more important than wages?

11. What does it mean to have "respect" for your superiors?

Roland Peterson

ED035773

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OF
NEBRASKA

approx 218

TRACTOR REPAIR
AND
MAINTENANCE
COURSE OF STUDY

U. E. Wendorff

Publication No. 3 -- 1965

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FOREWORD

This course of study guide in Farm Tractor Mechanics has been prepared by U. E. Wendorff, Assistant Professor of Agricultural Engineering and Agricultural Education for use with the project entitled "An Experimental Evaluation of Approaches to Preparing High School Students for Agricultural Occupations Other Than Farming," which is being conducted in the Department of Agricultural Education, College of Agriculture and Home Economics, University of Nebraska. It is designed to be used in the specific related instructional program for preparing students for initial employment as tractor mechanic helpers and related occupations. However, it has been designed to be used in conjunction with units of instruction dealing with tractor maintenance in the regular vocational agriculture program.

Acknowledgement is due Professor Wendorff for his contribution to the project through the medium of this publication, and for the service that he has rendered to vocational agriculture teachers and coordinators of diversified occupations and related programs by preparing this publication.

John K. Coster
Project Director

TO THE STUDENT

This course of study guide has been developed for use in preparing students for employment as tractor mechanic helpers, as part of cooperative work experience programs in vocational education. It may be used in regular vocational agriculture programs or in preparing students for off-farm agricultural occupations dealing with tractor maintenance or repair. It deals with the more elementary phases of tractor maintenance, and is designed as an initial course in tractor maintenance to cover approximately 90 hours of instruction. You will need additional training if you desire to become a skilled tractor mechanic.

The units in this guide are designed for individualized instruction. They are also designed to be used in connection with laboratory work on the tractor. They provide for step-by-step directions for your experience. Supplementary readings are assigned to help you master the necessary knowledges and skills involved in tractor maintenance and repair.

Be sure that you have all the references available before you start on the tractor instructional program. It is especially important that you have an operators' manual for your own use. After you have completed the unit, answer the questions, using the separate booklet that provides for the answers. Do not write in this guide.

Do not hesitate to ask questions of your teacher as you progress through the guide. He will want to check your work frequently, especially with regard to the adjustments that are necessary. He may also help you to find additional references.

As you progress through this course, you should keep in mind that you are beginning to master some basic principles and acquire skills that any skilled, successful mechanic needs. The training that you receive as the result of following through with this guide will be useful to you regardless of whether you eventually obtain employment as a farmer, a tractor mechanic, an automobile engine mechanic or an airplane engine mechanic.

You should also keep in mind that as you progress through this first course in tractor mechanics, you should try to develop the characteristics of a good mechanic. Some of these important characteristics are:

1. Safety. A good mechanic observes simple rules of safety. He makes sure that parts are secured so that they will not fall on him or on one of his fellow workers, and he learns to lift heavy parts carefully and properly. Ask your teacher to demonstrate proper lifting procedures.

2. Cleanliness. Observe a skilled mechanic at work. You will note that he is extremely careful about keeping both the parts that he disassembles and

his tools absolutely clean. Be sure that you have an ample supply of wiping cloths and cleaning solvent available before you start to work on the tractor. Clean the tractor thoroughly before you start to disassemble the tractor.

3. Care of tools. A mechanic's tools are his most prized possessions. Perhaps you may start to assemble your own tool kit. Get into the habit of cleaning your tools thoroughly after use, and placing them in their proper location after you have used them. Always use the proper tool for each job.

4. Follow instructions. Get into the habit of reading and following instructions carefully. If the instructions are not clear, ask for help. Do not guess.

5. Adjust carefully. Perform your adjustments carefully. Make sure tolerances are exact. Never be satisfied until the adjustments are perfect. There is no margin for error. Tolerances are designed to produce maximum effective performance, and it is up to the mechanic to observe the tolerances and adjustment instructions if the tractor is to be maintained in proper working order.

6. Constantly inspect. Always be on the alert for worn or defective parts. Inspect and check constantly. Repair or replace worn or broken parts as you work.

REFERENCES

A. American Oil Company, *Farm Tractors -- Basic Principles, Operation and Maintenance*. Engineering Bulletin No. FT-53: Chicago: American Oil Company, 1963

B. Brown, Arlen D., and Ivan Gregg Morrison, *Farm Tractor Maintenance*. Third edition: Danville, Ill.: The Interstate, 1962

C. Promersberger, William J., and Frank E. Bishop, *Modern Farm Power*. New York: Prentice Hall, Inc., 1962

D. Southern Association for Agricultural Engineering and Vocational Agriculture, *Tractor Maintenance -- Principles and Procedures.* Athens, Ga: . The Association, 1964

E. Tractor Operator's Manual supplied by manufacturer.

F. McCreight, M.G., *Farm Tractor Maintenance*. A Series of six 35 mm colored filmstrips: Lincoln, Nebr.: Bureau of Audio-Visual Aids, University of Nebraska, 1962

F_1 -- Electrical System

F_2 -- Lubrication

F_3 -- Fuel System and Fuel Storage

F_4 -- Cooling System

F_5 -- Air Cleaner and Crankcase Vent Servicing

F_6 -- Hydraulic System and Miscellaneous Tractor Maintenance

Unit I

Servicing the Tractor Electrical System

Introduction

In internal combustion engines, which are designed to burn gasoline, tractor fuel, LP Gas, and similar fuels, the air fuel charge is ignited by a high voltage electrical spark jumping a spark plug gap. Two kinds of electrical ignition systems are used on farm tractors: the battery system and the magneto system. The battery system is used more often on modern farm tractors than the magneto system. The principle difference between these two systems is the primary source of electrical current. The battery system transforms the relatively low voltage of a storage battery into a high voltage current to jump the gap at the spark plug. In the magneto system, the current generated by the magneto is also transformed to a high voltage current and to the gap at the spark plug.

The battery type ignition system consists of a battery, a coil for transforming low voltage current to high voltage, and a distributor which interrupts the primary circuit and carries the high voltage current to the proper plug. The battery type system is also used on automobile engines.

The distributor carries the current to each spark plug at the proper time. It usually rotates at one-half engine speed. The spark plugs and ignition wires leading to the spark plugs are also a part of the electrical system.

The spark plug ignites the fuel charge. When the high voltage current jumps the spark plug gap a spark occurs. The width of the gap between the points of the two electrodes of the spark plug needs to be very carefully and precisely set, because incorrect setting can affect engine operation adversely.

Where a battery ignition system is used there must also be a generator to keep the battery charged. Wherever proper maintenance procedures are followed, as recommended by the operator's manual, the generator is usually trouble free.

The storage batteries are similar to those used in automobiles. They may be either 6 or 12 volts; the 12 volt systems generally are used on newer tractors.

Assignment

Select an engine or farm tractor and work through the steps under each servicing area. Hand in the work and study guide questions as soon as they are complete.

References:

C. Modern Farm Power, - Chapters 1, 2, 3, & 10.
A. Engineering Bulletin - Pages 41 to 51.
D. Tractor Maintenance - Principles and Procedures.
F_1 (Electrical System) Film Strip.

A. Servicing the Battery

Steps
(1) Remove battery and clean thoroughly with baking soda and water using a wire brush. Rinse thoroughly with water to remove all traces of acid.
(2) Check openings in vent caps and clean if necessary. Add water to battery until it reaches the proper level, slightly above the plates.
(3) Clean battery cable wires (terminal end) with pocket knife, round file, or special wire brush tool.
(4) Check specific gravity of each cell with a hydrometer; specific gravity should be between 1.250 and 1.275 at 80 degree F.
(5) Reinstall battery and tighten hold-down clamp to prevent vibration; tighten battery cables securely, but be careful not to damage posts.
(6) Coat battery terminals and cable ends with vasoline, cup grease, lacquer or a special battery spray to prevent corrosion.

B. Servicing the Starter

Steps
(1) Remove the starter from the engine and service every 500 hours.
(2) Remove end frames and inspect commutator. If dirty, clean with No. 00 sandpaper. If it is rough or the grooves are plugged, take it to a service shop.
(3) Replace brushes if badly worn.
(4) Check end frame bushings for wear. (Armature must not wobble as it is rotated.)
(5) Check contact points in starter switch -- use No. 00 sandpaper on pitted or corroded parts.
(6) Check and tighten all starter connections -- inspect insulation on all wires.

C. Servicing the Generator

Steps
(1) Remove the generator from the engine and service every 500 hours.
(2) Remove end frames and take out armature. Inspect the commutator for roughness or plugged grooves. If defective, take to electrical repair shop.
(3) Replace brushes with new ones if old ones are badly worn; seat new ones in with sandpaper.

MORE

(4) Check end-frame bearings for wear. If armature wobbles as it is rotated, take to repair shop for new end-frame bushings.
(5) Check generator regulator; file contacts if pitted or corroded.
(6) Check regulator for proper operation. If battery is fully charged, ammeter should show less than 5 amps charge. If battery is run down, ammeter should show 10 to 15 amps charge and should decrease as battery is recharged.

D. Servicing the Distributor

Steps
(1) Remove distributor from the engine -- remove distributor cap, rotor, and dustproof cover.
(2) Inspect contact points to see if they are pitted -- if pitted, remove and install new points.
(3) If contact points are removed for replacement, clean the breaker plate thoroughly and remove and install new condenser and rotor.
(4) Set point gap by rotating cam until breaker arm rests on high point on cam lobe -- then set to specifications (according to operators manual by using a float feeler gauge.
(5) Tighten down screws and lubricate cam with a drop of grease; new contact points have a grease capsule with them -- break open and put grease behind the rubbing block.
(6) If new points are installed, remove the protective oil on the contacts by running a clean rag between them -- inspect to make sure points line up and match perfectly. (Bend carefully to adjust the alignment.)
(7) Clean the distributor cap and inspect for cracks.

E. Timing the Distributor to the Engine

Steps
(1) Turn engine over until piston no. 1 is at top dead center (timing marks on flywheel or crankshaft pulley will be lined up perfectly) on the compression stroke. Both valves must be closed. (Timing marks line up and piston is at TDC on the exhaust stroke as well as on the compression stroke.)
(2) Replace distributor cap on the distributor and replace spark plug wires in their correct firing order in the cap.
(Allis-Chalmers 4 cyl. 1-2-4-3)
(All other 4 cyl. tractors 1-3-4-2)
(6 cyl. tractor engines 1-5-3-6-2-4)
(3) Mark position of no. 1 terminal in the cap on the body of the distributor with a piece of chalk directly below the cap terminal. Remove distributor cap.
(4) Install distributor in the engine with the rotor pointing straight at the chalk line on the distributor body.
(5) Rotate distributor slightly either way until points are just starting to break -- tighten distributor hold-down clamps.
(6) Install distributor cap and connect wires to spark plugs in the proper firing order.

MORE

(7) Recheck timing by chalking the timing marks so they can be clearly seen, then connect timing light to no. 1 spark plug and observe to see if timing marks are lined up. Rotate distributor either way for fine adjustment until marks do line up. Never set timing beyond the marks; slight retarded timing is permitted, but do not advance the timing. (Run engine as slow as possible while using the light. If vacuum advance line to carburetor is above the throttle valve, remove the vacuum line and plug while testing.

F. Timing the Magneto to the Engine

(Most newer tractors have a battery ignition system instead of the magneto. However, older tractors commonly used the magneto ignition. The important thing to remember is that the magneto works on the same principle and is timed in almost the same way.)

Steps

(1) Crank the engine over until no. 1 piston is on TDC on the compression stroke.
(2) With the distributor cap removed from the magneto, locate the rotor so it is in position to deliver the spark to no. 1 cylinder.
(3) Some impulse couplings will require turning the magneto until impulse trips then reverse until distributor is back in position to deliver spark to the no. 1 piston.
(4) Attach the magneto on the engine, making sure that the lugs on the impulse coupling engage in the slots on the magneto drive coupling.
(5) Insert magneto mounting bolts loosely in the magneto flange, just enough to hold magneto in place.
(6) Attach magneto so that the top is as close to engine block as possible.
(7) Crank engine one complete revolution to next TDC and pull the upper part of the magneto away from the engine until impulse coupling just trips. Tighten mounting bolts securely.
(8) Recheck timing with timing light or check by cranking the engine slowly. The impulse coupling should trip each time when timing marks line-up or timing light goes on. (Check operator's manual for correct lines to time the engine on.)

G. Servicing the Spark Plugs

Steps

(1) Disconnect wires and remove spark plugs with a special plug socket to avoid damage to insulators.
(2) Examine plugs to determine if proper type has been used. Hot plugs have long insulators and should be used with low-grade fuels or for start and stop operation. Cold plugs have short insulators and are used with high-octane fuels. (Check operator's manual for proper type -- medium heat range plugs are most commonly used.)

(3) Inspect plug to analyze engine operating condition:
  a. Oily Plug: due to bad rings, worn rod bearings, worn valve guides, etc.
  b. Carboned Plug: engine is running too cold, due to carburetor being set too rich, too heavy a fuel being used, using too cold a spark plug, bad thermostat, etc.
  c. White, Blistered, Burned Plug: engine is running too hot due to advanced timing, lean fuel mixture, too hot a spark plug, etc.
  d. Ash-Grey Plug: Normal spark plug.

(4) Examine insulator for cracks and determine if electrode and plug is good enough to clean and reinstall.

(5) If plugs are to be replaced clean with sand blasting equipment if available.

(6) Use a thread-cleaner if available to clean plug threads in the cylinder head. Clean threads on the plugs with a wire brush.

(7) File electrodes until smooth and parallel, re-gap to proper specifications according to operator's manual (about .025 to .035), use a round feeler gauge rather than a flat one for used plugs.

(8) Replace copper gaskets; coat plug threads with light oil and replace in cylinder head.

(9) For proper tightening without a torque wrench, turn plugs down by hand as far as they will go, then tighten approximately 3/4 turn more. (Tightening too much will change the plug gap so it is too close.)

(10) If new plugs or gaskets are used, tighten down until you just "crush" the gaskets.

H. Examine and Reconnect Spark Plug Cables

Steps

(1) Inspect cables for cracks or weather-checked insulation.

(2) Clean oil and grease from cables. (Oil causes rotting of the insulation.)

(3) Reconnect cables, making sure all connections are clean and tight.

Roland Peterson

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Unit I

Work and Study Guide Questions

1. After removing and cleaning the battery, record the specific gravity of each cell.
   1. ________ 2. ________ 3. ________ 4. ________ 5. ________ 6. ______

2. Why is it important that the starter commutator be clean? How did you clean the commutator?

   ____

   ____

3. Explain how to remove the dirt and glaze from the commutator on the generator. Why not use emery cloth? ____________________

   ____

   ____

   ____

4. Check the operator's manual and locate the timing marks on your tractor. Where were they found?

   ____

5. What is the firing order of your engine?

   ____

6. After removing and disassembling the distributor, check the breaker points for pits and corrosion. What causes the points to be badly burned?

   ____

   ____

   ____

7. Replace the distributor and retime your engine. Describe the procedure followed.

   ____

   ____

   ____

   ____

8. What was the breaker point gap? ____________________

9. After cleaning the plugs, check and list the gap as found in each plug.
   1. ______ 2. ______ 3. ______ 4. ______ 5. ______ 6. ______ 7. ______
   8. ______

Test on Tractor Electrical System

Encircle correct answer.

T F 1. Use baking soda and clean water to clean the top of a storage battery.

T F 2. In cold weather, protect the battery from freezing by keeping it fully charged.

T F 3. Storage batteries on most tractors are either 3 or 6 volts.

T F 4. The electrolyte is dilute hydrochloric acid having a specific gravity of about 1.280.

T F 5. A thermometer is used to check the specific gravity of each cell of the battery.

T F 6. Only distilled water should be added to a storage battery.

T F 7. Each cell in a storage battery produces approximately 3 volts.

T F 8. Current is produced by the distributor and fed into the storage battery to keep it charged.

T F 9. Dirt on the commutator of the starting motor may be cleaned off with emery cloth.

T F 10. The purpose of the distributor is to take the spark to each spark plug at the right time.

T F 11. Set the point gap in the distributor according to the operator's manual.

T F 12. Use a float feeler gauge when setting the point gap.

T F 13. When timing a multiple cylinder engine you should start by placing the number 1 cylinder on top dead center of the compression stroke.

T F 14. Most newer tractors have a magneto ignition system instead of a battery.

T F 15. Any type of spark plug can be used in an internal combustion engine.

T F 16. Inspect spark plug to analyze engine operating condition, oily plugs are due to bad rings, worn rod bearings, worn valve guides, etc.

T F 17. A float feeler gauge is used when regapping spark plugs.

T F 18. Oil on the spark plug cables will cause rotting of the insulation.

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Unit I

Key to Electrical System Questions

1. T (D-51)
2. T (B-113)
3. F (B-113)
4. F (D-5)
5. F (D-7)
6. F (D-6)
7. F (B-113)
8. F (B-122)
9. F (B-125)
10. T (B-105)
11. T (B-106)
12. T (D-84)
13. T (D-86)
14. F (D-77)
15. F (D-43)
16. T (D-47)
17. F (D-49)
18. T (D-50)

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1. E-
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3. D-91
4. D-88
5. E-
6. D-82
7. D-86
8. E-
9. D-49